The Engineer

LONDON, FRIDAY, AUGUST 21, 1942.

PUBLIC NOTICES

STAFFORDSHIRE POTTERIES WATER BOARD

...ATGATE WORKS—CONTRACT No. 5

Above Board Invites

...TENDERS for the CONSTRUCTION of ... 9350 Yards of CAST IRON and ...TOS CEMENT WATER MAIN, the ...being 14in. and 18in. diameter, together ...e subsidiary works.

...s of the specification, bill of quantities, ...rm of Tender may be obtained from Mr. ...kinson, Assoc. M. Inst. C.E., Engineer to ...ard, at the address given below, on the ...t of a deposit of Five Pounds, which will ...rned on receipt of a bona-fide Tender and ...turn of all the documents. The plans and ... conditions may be seen at the Engineer's ...

...ers, in plain sealed envelopes, endorsed ...ers for Water Main," and addressed to ...hairman, Staffordshire Potteries Water ... Albion Street, Hanley, Stoke-on-Trent, ...e delivered not later than Twelve Noon ... 7th September, 1942.

...Board do not bind themselves to accept ...west or any Tender.

E. B. SHARPLEY,
Clerk to the Board.

...on Street,
Hanley, Stoke-on-Trent,
14th August, 1942. 8697

...IVERSITY OF MANCHESTER

PHYSICS DEPARTMENT

...ll Particulars of the

...LECTURES and LABORATORY ...SES in PHYSICS, preparing for both the ...ary and Honours Degrees, will be for... on application to the REGISTRAR. ...SESSION COMMENCES on Thursday, ...BER 1st. 8672

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LEICESTERSHIRE

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IMPORTANT

...ertisers in Situations Open Column ...uld make themselves acquainted with ... terms of

STATUTORY RULES & ORDERS 1941 No. 2069

...STRICTION ON ENGAGEMENT ORDER

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The Engineer

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NOTICE

CORRESPONDENCE *re* Accounts and Remittances should be sent in future to:

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This change has been caused by enemy action, and co-operation is earnestly asked for.

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THE Post You are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for the cost of Four Lines, 6s.; 1s. 6d. for each Additional Line. There is no better way of covering so large a field for such a small charge.

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CLASSIFIED ADVERTISEMENTS CLOSE FOR

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The Engineer

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Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of THE ENGINEER.

Postal Address,
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PATENTS

THE PROPRIETOR of BRITISH PATENT No. 488,590, dated March 23rd, 1936, pertaining to "Improvements in and relating to Bearings and Bearing Materials," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—Inquiries to SINGER, EHLERT, STERN and CARLBERG, Steger Building, Chicago, Illinois. 8691 H

THE PROPRIETOR of BRITISH PATENT No. 450,995, dated May 10th, 1935, relating to "Gyrating Screens," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—Inquiries to SINGER, EHLERT, STERN and CARLBERG, Steger Building, Chicago, Illinois. 8692 H

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TO ENGINEERING CONCERNS.—REQUIRED to PURCHASE, an established ENGINEERING BUSINESS in any sphere of Engineering. Outright purchase as a going concern, controlling interest, or amalgamation would be considered. Amount of capital involved immaterial, providing business stands investigation. Brief essential details invited in the first instance.—Address, P4313, The Engineer Office. P4313 F

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For continuation of Small Advertisements see page 56.

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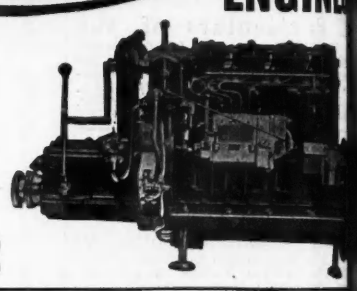

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A Seven-Day Journal

The Loss of H.M.S. "Manchester"

ON Friday, August 14th, it was announced by the Admiralty that the cruiser "Manchester" had been lost in the Mediterranean Sea, in addition to the aircraft-carrier H.M.S. "Eagle." The "Manchester" was a cruiser of the "Newcastle" class, and was built and engined by R. and W. Hawthorn, Leslie and Co., Ltd., on the Tyne. She was ordered in March, 1935, and her construction was begun at the end of March in the following year. She was completed early in August, 1938, and had a displacement of 9400 tons. Her water line length was 584ft., her beam 64ft. 4in., and her mean draught 17ft. 5in., with a maximum draught of 20ft. The armament of this cruiser comprised twelve 6in. guns, eight 4in. anti-aircraft guns, one 3·7in. howitzer, three three-pounders, and sixteen smaller guns. The torpedo tubes were six in number, arranged in triple mountings. Provision was made for the carrying of three aircraft and one catapult was fitted. The armour was 1in. and 3in. on the gun turrets, with 4in. and 3in. side armour and 4in. conning tower armour. The propelling machinery consisted of a four-shaft arrangement of Parsons geared turbines, taking steam from eight Admiralty three-drum oil-fired boilers. The rated output of the turbines was 82,500 S.H.P., corresponding to a speed of 32·3 knots. About 1970 tons of oil fuel were carried. The ship's complement was about 700, and a later Admiralty communication states that most of the ship's officers and company are safe. Three officers and 142 men were picked up by H.M. ships, and the remaining survivors are in French hands.

The Late Mr. C. J. Robinson

BY the death of Mr. Charles John Robinson, which took place at his home, "Summerhill," Newport, Shropshire, last Wednesday, at the age of eighty-three, the last link has been severed with the third generation of the Robinson engineering family which founded the firm of Thomas Robinson and Son, Ltd., of Railway Works, Rochdale. Mr. Robinson received his education at Clifton College and entered his father's firm, becoming a director in 1882. He was one of the five members of the third generation of the family who did much to raise the status of the firm and to increase its prosperity during the last half century. In 1893 the firm became a public company, and Mr. C. J. Robinson then became its managing director. During his many years with the firm, Mr. Robinson travelled extensively and made four visits to South Africa, three to Australia, and two to India on the firm's business. He was elected chairman of the company in 1909 and that office he continued to hold until his retirement in 1937, when he remained on the board as a managing director. He will be long remembered as a man of delightful personality, who combined with his outstanding business abilities a kindliness and charm of manner which endeared him to all who were privileged to enjoy his friendship.

American-Built Ships for Britain

ACCORDING to news from the United States, five 10,000-ton cargo ships built for Britain were launched together on Sunday last from the South Portland shipyard at Maine, while in the same area a further 10,500-ton "Liberty" ship and two destroyers took the water, making a new record for any area in America. The five ships were floated out from the Todd-Bath Iron Shipbuilding Yard at South Portland, Maine. At this yard, which was fully described and illustrated in our issue of August 1st, 1941, the ships are built in basins enclosed by a cofferdam, and are floated out and berthed at the 1000ft. fitting-out pier. As soon as the berths were clear, new keels were laid. Two of the ships launched on Sunday last were ready for launching only forty-eight days after the keels were laid, and three others after sixty-one days. It is reported that all the thirty standard "Ocean" class cargo ships ordered by the British Purchasing Commission from this yard will be completed ahead of contract time. At another shipyard nearby, a further ship of the "Liberty" class was launched, and on the same day two destroyers. The tonnage of the cargo ships totals over 61,000 tons. While these new records of American shipbuilding are noted, it is satisfactory to record that the loss of seven Allied ships during last week marks the lowest loss for some weeks past.

Railway Wages

DURING the last few weeks negotiations have been going on between the Railway Executive Committee and the National Union of Railwaymen, along with the Railway Clerks' Association, with regard to proposed increases in wages. On Monday evening last, after a meeting of the N.U.R. National Executive Committee, the terms of a new offer by the Railway Executive Committee were made known. The proposals of the Railway Executive Committee are as follows: "An increase of 4s. a week to all adult male staff, based on the composite rates now being paid, with the exception of firemen on the first and second year scales, to whom 3s. 6d. a week increase is offered. No increases are to be granted to engine drivers and firemen on the third year scale and upwards, or the dock staff. For the salaries staff, the proposed increases are: Male adults, £10 a year, except special grade; junior males, £5 a year; female adults, 3s. a week; female juniors, 1s. 6d. a week. Clerical staff on salary, equivalent rates, adults to receive 4s. a week, juniors 2s. a week. The National Union of Railwaymen has offered to circularise the offer to its different branches, and a delegate conference has been called to consider it, and will meet on Tuesday, September 1st.

Dock and Ship Salvage in Eritrea

INTERESTING and successful salvage work is being carried on at the former Italian naval base at Massawa, in Eritrea, which was captured by British forces. Before capitulation the Italian and German captains decided to scuttle all their ships and dry docks, and twenty-six ships, a floating dry dock which is designed to handle 10,000-ton cruisers, and a smaller floating dock were sent to the bottom. Salvage operations have been begun by Captain Edward Ellsberg, who had charge of the raising of the United States submarine "S 51," which was sunk off Block Island in 1925. Captain Ellsberg is assisted by a staff of thirteen American civilian divers. Work was begun on May 11th, and by May 20th the large dry dock was again afloat. It is considered that all the Italian and German ships can be successfully salved. Most of these ships, it is reported are cargo-passenger vessels of 5000 tons, while two others are 14,000-ton German liners. Work on one ship was started on June 3rd, and by July 1st she had begun to rise, and three days later she was fully afloat.

Loss of Aircraft Carrier H.M.S. "Eagle"

ON Wednesday, August 12th, it was officially announced by the Admiralty that the aircraft carrier H.M.S. "Eagle" had been sunk by a German submarine in the Mediterranean Sea. A later announcement confirmed the rescue of 930 survivors, including Captain L. D. Mackintosh, 67 officers, and 862 ratings. H.M.S. "Eagle" was one of the oldest of British aircraft carriers, and she is the fifth to be lost since the beginning of the war. She was designed and begun in 1913 as a "Dreadnought" battleship for the Government of Chile, at the naval yard of Armstrong, Whitworth, and her name was to have been the "Almirante Cochrane." Work on her was abandoned in 1914, and she lay on her building slip until 1917, when she was bought from the Chilian Government. Plans for her conversion to an aircraft carrier were prepared by Sir Eustace Tennyson d'Eyncourt, work being begun in June, 1918, and completed in April, 1920. After trials had been made she was modified in November, 1920, at Portsmouth Dockyard, and was finally completed in 1924. She had a displacement of 26,600 tons, a length of 667ft. overall, a beam of 92ft. 9in., with 100ft. at the flight deck and 105ft. 2in. maximum, and a mean draught of 24ft. Her official complement of aircraft was twenty-one. The armament included nine 6in. guns, four 4in. A.A. guns, and twenty-two smaller guns. She was protected by side and deck armour and by bulges projecting about 6ft. from her sides, which extended over four-fifths of her length. Her machinery comprised an arrangement of Brown-Curtis turbines, built by John Brown and Co., Ltd., at Clydebank, taking steam from thirty-two Yarrow boilers. The normal amount of oil fuel carried was 2500 tons, but a maximum capacity of 3750 tons was provided for. The ship was refitted in 1932.

Private Electricity Generating Plant and Electricity Supply

THE Electricity Commissioners have had under careful consideration the possibility of making use of any surplus private generating plant to augment public supplies of electricity. In view of the imperative need to reduce coal consumption, the Commissioners have been asked to co-operate in securing—in appropriate cases—the best possible use of any back-pressure generating plants. It is possible that owing to the conditions under which public supplies of electricity are furnished to premises where such plants are installed the steam which may be required for heating or process work is not being used to the fullest extent for the generation of electric current. In such circumstances the Electricity Commissioners are asking that consideration should in appropriate cases be given during the present energency to the relaxation of any imposed conditions of operation which may be precluding the most economic use of private electricity generating plants. Further consideration, they suggest, should be given to arrangements by which any surplus electricity so produced could be economically absorbed into the public electricity supply system. In a circular letter which early last month was sent by the Commissioners to the engineers and managers of all electricity undertakings, the Commissioners suggested that if it would assist in dealing with any of these problems which might be raised in connection with the suggestions outlined above, they would be pleased to offer the services of one of their Engineering Inspectors to discuss the proposals.

The American "Thunderbolt" Fighter

WITH the recent publication of the details of the newest German fighter aircraft, the Focke-Wulf, described in our last issue, more than usual interest attaches to the preliminary information concerning the new American fighter aircraft, the P.47 or "Thunderbolt," which was recently claimed by General H. H. Arnold, the Commanding General of the United States Army Air Force, to be a machine which can outfight and outfly any other known aeroplane. Although good photographs of the new fighter have come to this country, very little so far is known concerning the details of the new machine, its engine, and its armament. The engine, we are given to understand, is of 2000 B.H.P. Pratt and Whitney radial design, incorporating in its construction an exhaust turbine supercharger, taking its power from the exhaust gases of the engine. The new fighter has been credited with a speed of about 400 m.p.h., while it can be flown under Service operating conditions at heights exceeding 40,000ft. The weight of the fully equipped machine has been mentioned as something like 13,000 lb.

Excavating Machinery in the Ironstone Fields

By W. BARNES, M.I. Mech. E.

No. III

(*Continued from page 129, August 14th*)

IN 1909 Whitakers also made an ingenious attempt to combine in a stripping excavator a single-bucket shovel and transporter in one machine with the idea of obtaining the rapid working of a short-jib single-bucket excavator with the dumping reach of a long-boom shovel to eliminate the slewing time. This machine was purchased by the Loddington Ironstone Company. A common framing and tower supported the excavating equipment on one side and the transporter on the other. The transporter was of the skip type, but to avoid the possibility of the excavator having to wait to dump its load into the skip two skips were interconnected on the haulage system. These ran on separate tracks, one above the other, terminating in a single track at the lower end. The bucket arm followed the usual shovel type of design, but instead of swinging the boom for dumping, the material was discharged into the skip by continuing to hoist the bucket after a cut was completed, until it was hoisted up under the boom head between the sides of the boom and over the mouth of a chute leading to a skip waiting to receive its load over the swing circle at the foot of the chute. This method of dumping eliminated the usual loss of time in swinging or slewing the machine, or front end excavating equipment, to dump the material. The idea was successful, and in 1913 the Loddington Ironstone Company ordered an improved machine of the same type, weighing 85 tons, from Ruston, Proctor and Co. This machine is still working. An operator and youth as fireman were employed on the machine and three or four men around it—Fig. 11.

A similar type of machine in principle, but different in design, was also made by Henry Berry and Co. to the design of D. Whitaker for the Rothwell Quarry of the Stanton Ironworks Company, but it was not so successful as the two previous machines and did not work for long.

In 1913–14 Ruston, Proctor and Co. introduced the Ruston No. 20 steam crane navvy, which they specially designed to meet most of the conditions in the ironstone fields. It was mounted on rail wheels, previous to the introduction of caterpillar tracks, weighed 62 tons, and was fitted with a bucket of 2¾ cubic yards heaped capacity. The first machine was purchased by the Midland Ironstone Company, Ltd., for digging ironstone at Frodingham. A daily output of only 400 tons was required from the pit where the machine was installed, and it was purchased under a guarantee that the working cost, exclusive of maintenance and capital charges, would not exceed 1·75d. per ton of ironstone. The actual cost worked out at 1·5d. per ton, which included the cost of two men upon the machine and five around it for cleaning up the bottom, spotting the wagons, and breaking large pieces of ironstone down to the maximum size stipulated by the blast-furnace managers. Coal consumption amounted to 18 cwt. per day for the output mentioned. An interesting feature of this particular machine was the patent bucket door, by

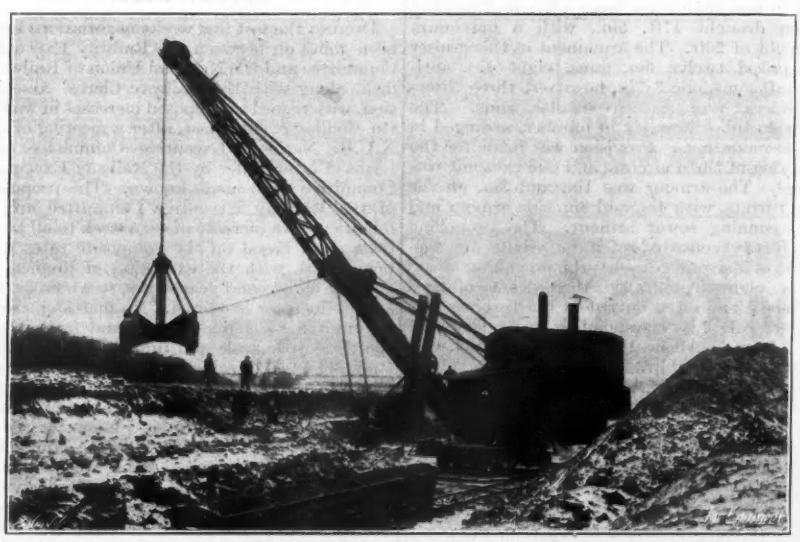

FIG. 12—RUSTON COMBINED EXCAVATOR AND GRABBING CRANE—1916

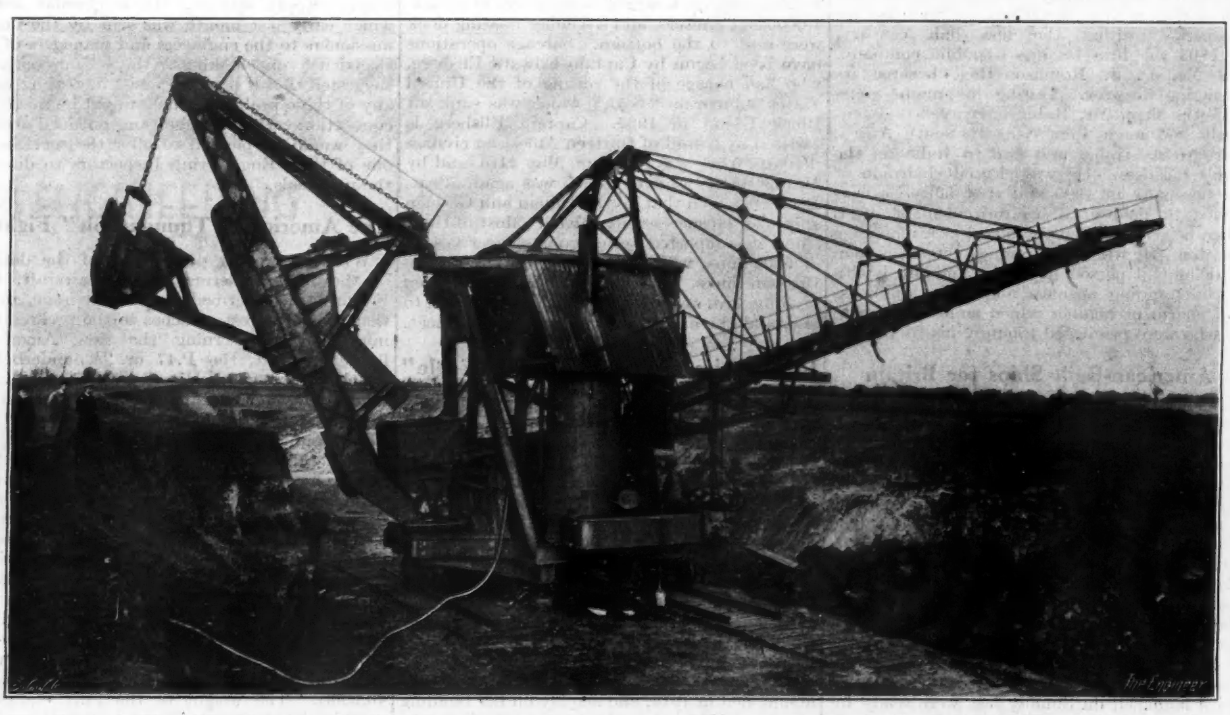

FIG. 11—RUSTON COMBINED SINGLE-BUCKET EXCAVATOR AND SINGLE-TRACK CONVEYOR—1914

means of which the rate of discharge from the bucket could be controlled to avoid damage to standard railway wooden wagons into which the ironstone was loaded for transport to the blast-furnaces.

It should be noted that the 400 tons of ironstone required was less than half the digging capacity of the machine, which meant that the excavator was idle for half its possible daily working time. A smaller and less powerful machine was not, however, recommended, because of the power required to dig the ironstone without the assistance of explosives.

In 1916 it was considered undesirable that the machine should be idle for about 50 per cent. of the working day, especially as men were employed to remove about 3ft. to 5ft. of cover. A similar size of machine was, therefore, specially designed with the boom extended to carry a suitable size and type of grab to excavate the cover and dump it over on to the worked-out ground—Fig. 12. The machine with grab attachment removed the cover approximately half the day, the bucket being racked in and fastened back to the boom during the time the machine was being worked as a grab. When sufficient cover had been removed and it was required to dig the ironstone, the grab was detached and the grab-holding rope coupled to the bucket for controlling the door. The idea

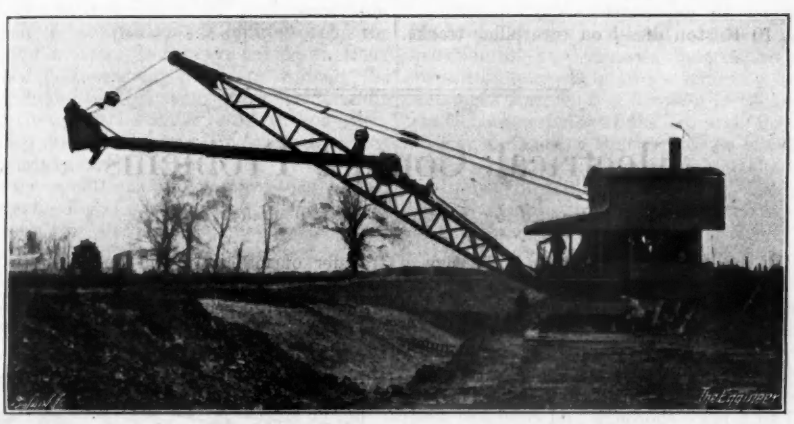

FIG. 13—RUSTON STRIPPING SHOVEL WITH LATTICE BOOM—1915

proved very successful in practice and similar combined excavators and grabbing cranes were purchased for use by the Loddington Ironstone Company, Charwelton Ironstone Mines, and Sproxton Ironstone Mines.

The combined steam navvy and grabbing crane was only one of the many modifications made to this No. 20 machine to meet conditions in the ironstone fields. Originally it was fitted with a 26ft. boom, this being sufficient to meet most of the ironstone digging conditions; later it was obtainable with a 31ft. boom for dealing with deeper faces of ironstone or to give a greater dumping height over the wagon, still using the 2¾ cubic yard bucket.

It was also fitted with a long lattice boom, with a working angle of about 30 deg. to the horizontal, in conjunction with a 1 or 1¼ cubic yard bucket, the size depending upon the nature and weight of the material—Fig. 13. The dumping radius was 60ft., which enabled the machine to be used as a stripping shovel to dump the material direct without the use of a transporter up to from 15ft. to 20ft. of cover. Machines of this type were supplied to Lord St. Oswalds Ironstone Company, Stanton Ironworks Company, Wellingborough Iron Company, Lysaghts, Bloxham and Whiston Ironstone Company, &c.

For deep material or high dumping the machine was fitted with a plated boom, 55ft. long, fixed at an angle of about 60 deg. This gave a digging height of over 50ft., a dumping height of 40ft., and a maximum dumping radius of 52ft., but as this radius was insufficient to deal with more than about 15ft. of cover the machine was sometimes used in conjunction with a skip transporter to enable the combination to deal with about 40ft. of cover.

Because of the many combinations to meet varying working conditions in the ironstone fields over a hundred No. 20 Ruston excavators were purchased by various companies.

The year 1916 saw the introduction of the

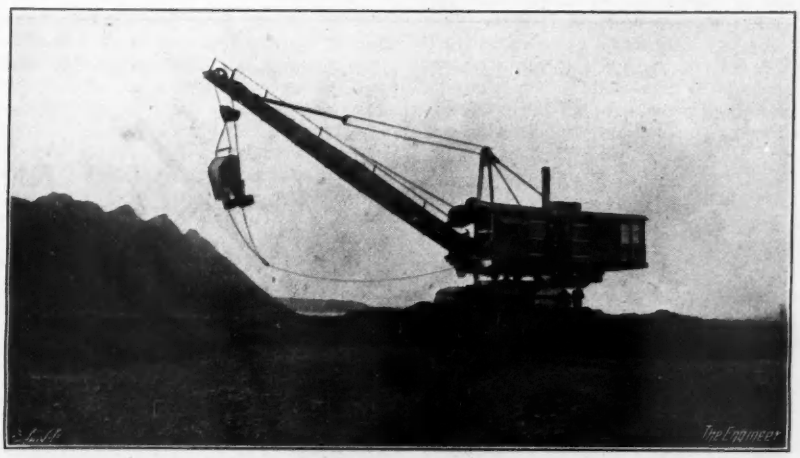

FIG. 14—BUCYRUS DRAGLINE—1917

first dragline excavator into the ironstone industry. This was an American machine, a Class 14 Bucyrus, and it was purchased by William Baird and Co., Ltd., for stripping ironstone on the island of Raasay, North-West Scotland. This machine was mounted on caterpillar tracks, weighed approximately 84 tons, and was fitted with a 2 cubic yard bucket on a 60ft. boom. Its use was discontinued soon after the last war, but it is still at Raasay.

During the 1914–18 war five other Bucyrus draglines were purchased by S. Pearson and Sons, Ltd., and Sir Robert McAlpine and Sons, Ltd., for use on large Government contracts. One of these machines, a Class 9½ with 1½ cubic yard bucket and 45ft. boom, was employed in 1917–18 to open up new workings at Stainby for Stanton Ironworks Company—Fig. 14. Two more of these machines, Class 14s, were also purchased in 1929 and 1931 by the same company for use in its Buckminster mines and one by the Partington Iron and Steel Company for a new mine at Wakerley.

In 1916 Lloyds Ironstone Company made another progressive move when it purchased a Bucyrus 175B stripping shovel to enable it to cope with increasing depths

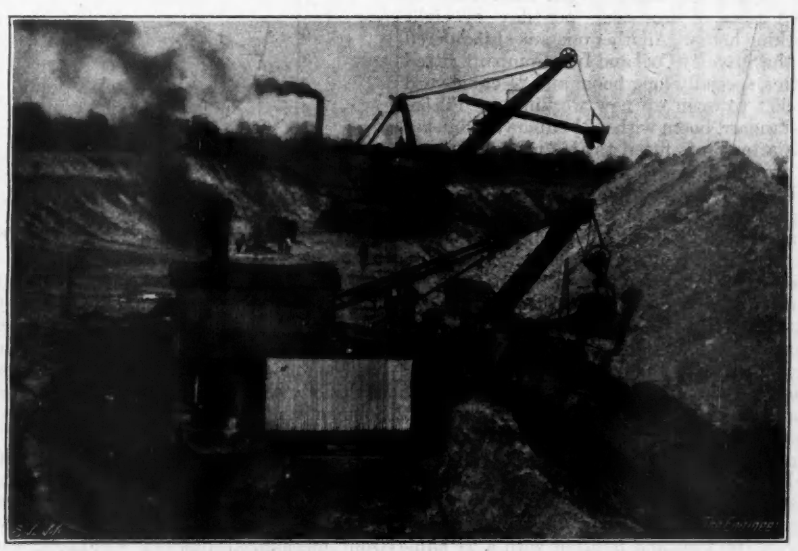

FIG. 15—LONG BOOM STRIPPING SHOVEL AND IRONSTONE DIGGER

of cover. This machine was fitted with a 3½ cubic yard bucket to dump at a radius of 85ft. and weighed 190 tons. The machine was still in use in 1942.

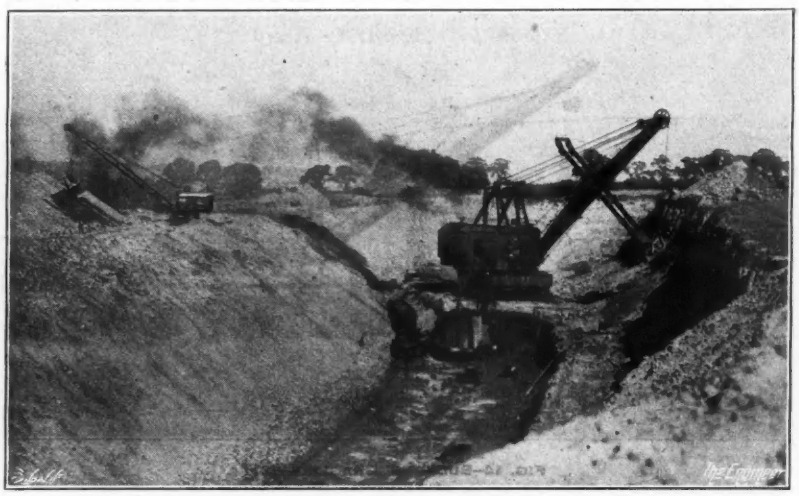

FIG. 16—ELECTRIC DRAGLINE RE-HANDLING EXCESS OVERBURDEN

A still larger machine of the same type, a Bucyrus 225B, was purchased by the Cranford Ironstone Company in 1918 to deal with about 50ft. of cover. This machine, which is still in use, is fitted with a 5 cubic yard bucket on an 80ft. boom for a dumping radius of 103ft. and weighs approximately 300 tons.

In 1922–23 Lloyds Ironstone Company made another move to deal with still deeper cover and placed an order for a No. 300 Ruston stripping shovel, similar in design to the 225B at Cranford, but with 6 cubic yard bucket, 80ft. boom, and 94ft. 6in. dumping radius—Fig. 15. This machine is still in use, weighs about 350 tons, and will remove about 2000 cubic yards of cover per day of eight hours. A similar machine was supplied to Irchester Ironstone Mines in 1930, but with a 5 cubic yard bucket, 95ft. boom, and 113ft. dumping radius.

In 1919 Ruston and Hornsby constructed a No. 30 crane navvy fitted with a 3½ cubic yard bucket for digging ironstone at Scunthorpe. Orders for these machines were placed by the Lord St. Oswald and Frodingham Iron and Steel Company. These machines are capable of dealing with from 1800 to 2000 tons of ironstone per day of eight working hours. Another one was also ordered by the Staveley Coal and Iron Company, fitted with a specially long boom and 2½ cubic yard bucket to open up new workings at Pilton. A standard boom with a 3½ cubic yard bucket was afterwards fitted to this machine to use in conjunction with a skip transporter.

In 1925 the Stanton Ironworks Company suggested the use of a dragline at Harston, near Grantham, to remove shallow overburden and not only dig the top soil and subsoil separately, but dump them in their correct relative positions so that the worked-out land could be restored for agricultural purposes. The idea proved remarkably successful with the Ruston No. 10 dragline mounted on caterpillar tracks, which was purchased to carry out the experiment. It was the forerunner of much progress in this direction.

In 1925 the Pitsford Ironstone Company installed a No. 135 Ruston long-boom stripping shovel. This machine weighs about 160 tons and is fitted with a 2½ cubic yard bucket, dumping at a radius of 85ft., and will deal with about 30ft. of cover.

In 1930 the Cranford Ironstone Company introduced a dragline to rehandle a proportion of the material at one end of the pit, which was too deep for the big Bucyrus stripper to deal with. This machine, a No. 10 Ruston diesel on caterpillar tracks, stands on large timber mats placed on the surface of the dump and rehandles and casts back about 10 per cent. of the overburden dumped by the big stripper to provide the necessary amount of dumping space for the remainder.

The idea was successful and in 1934 the Cargo Fleet Company purchased a 43-B electric dragline for its Irchester mines to rehandle the excess overburden from its big Ruston No. 300 stripping shovel—Fig. 16.

All the foregoing machines were steam driven excepting the diesel dragline for the Cranford Ironstone Company and the electric dragline for Irchester. Between 1925 and 1933 no outstanding developments or progress can be recorded, although Rustons had produced a No. 20 electric quarry type shovel, which was demonstrated to the ironstone industry in the Frodingham Ironstone Mines. It did not, however, meet with much favour, as at that time cheap electric power was not readily available in the mines. The years 1933–34, however, marked the general introduction of diesel and electrically operated machines into the ironstone industry, the Stanton Ironworks Company, Stewarts and Lloyds, and Frodingham Iron and Steel Company leading the way. Stanton's purchased a Ruston-Bucyrus ⅔ cubic yard diesel dragline for removing shallow overburden in its limestone quarry at South Witham and in its ironstone mines at Sewstern, a few miles away.

(To be continued)

Electrical Contact Problems

(Contributed by Compound Electro Metals, Ltd.)

THE recent progress made in the design of switches, circuit breaker and other switchgear has caused a demand for increased efficiency of contacts for this type of apparatus. It has therefore been necessary to study and investigate theoretically the problems of electrical contacts. This has led to a more thorough and complete study of contact problems and naturally has led to the development of new material. Further, the progress of powder metallurgy has given us new contact metals with many variations in physical properties. Numerous metallurgical questions concerning contact metals and their requirements could only be answered through electronic research work. This phase has been made possible in the past few years, as this branch of physics has rapidly advanced. Some of the problems to be overcome are as follows :—

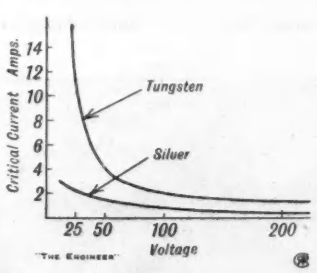

FIG. 1—CRITICAL CONDITIONS FOR CONTACTS

The contacts may deteriorate by heat developed in the contacts under constant carrying of high current, through arcing caused by the switching operation and wear from mechanical motion. Contacts, which have been operated for some time, show a transfer of material from one part to the other. This is caused by electric sparking, of which there are principally three types :—

(1) *Arcs.*—It has been found that a D.C. of at least 10–20 volts and 0·2 to 2 amperes is required to start and maintain an arc.

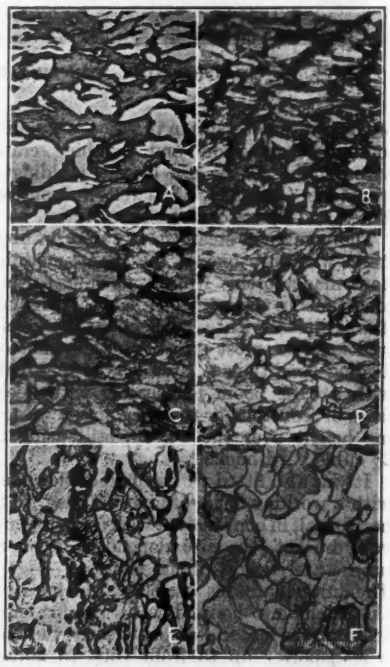

FIG. 2—MICROSTRUCTURE OF COMPOUND CONTACT METALS

(2) *Glow Discharge.*—This may occur at

very small currents, but requires at least 300 volts D.C. to start.

(3) *Cold Electron Discharge.*—This may occur if the contact opening is very small and the field intensity very high.

Incidentally, these three phenomena have been utilised in the electronic industry commercially. The arc, of course, is used in many places, one of the first being the old arc lamp and more recently the new high-intensity mercury vapour lamp. Glow discharges are used in various types of lamps, such as neon signs. Cold electronic discharge is used in certain types of condensers.

In view of the fact that the so-called electron discharge and the glow discharge, owing to their low current, cause only very little transfer of the material as compared with the arc, they will not be discussed here.

Critical Current

As mentioned before, an electric arc only occurs when making or breaking a circuit of at least 10–20 volts and 0·2 to 2 amperes D.C. Therefore, under certain conditions it is possible to find contacts interrupting circuits without an arc being formed. The formation of an electric arc is dependent upon the dielectric medium between the contacts, and the above-mentioned values are with air as the dielectric medium. If a specific type of contact is operated in air with a certain temperature and humidity, the question of whether or not arcing will occur when the circuit is broken depends entirely upon the current flowing. As Burstyn has shown, there is a definite current for every voltage, the so-called critical current, which just permits the circuit to be interrupted without producing an electric arc. This critical current depends to a great extent upon the material, surface condition, and temperature of the contact. Fig. 1 shows curves of the critical currents for two contact materials, highly conductive silver, and hard and dense tungsten. Table I gives data of critical currents for graphite and various pure metals and alloys. This table shows that at 50 volts an electric arc will be formed between silver contacts at a current one-quarter as great as that needed between tungsten contacts. Increase of contact temperature reduces the critical current for most materials, for increase in temperature increases the electronic emission of a metal.

Table I.—*Critical Current (in Amperes) for Different Materials*

Voltage.	Graphite.	Cu.	Mo.	Ni.	Pb.	Ag.	W.	Brass.
25	—	—	18	—	7·5	1·7	12·5	—
50	5	1·3	3	1·2	3	1	4	0·7
110	0·7	0·9	2	1	0·85	0·6	1·8	0·4
220	0·1	0·5	1	0·7	0·7	0·25	1·4	0·3

Conductivity

By using proper dimensions and by selecting suitable contact materials of high thermal conductivity it is possible to reduce the heating of contacts. The conductivity of the material depends upon the number of its free electrons. It may be of academic interest to mention here that free electrons can be released by outside sources of energy, such as ultra-violet radiation. For example, glow discharges or arcs may be started between two surfaces by allowing ultra-violet rays to fall upon them. In the same way, non-conductors, diamond or zinc sulphide, for example, can be made conductors by ultra-violet radiations. The electrical conductivity of a material can be calculated from the characteristic data of its electrons, and depends upon their charge, mass, average velocities, effective number, and average mean free path. The average mean free path and the average velocity of electrons are calculated by means of wave mechanics. They are functions of the thermal movement in the atomic lattice of deformation of crystals and the purity of the metal. It is well known that there is a relation between electrical conductivity and heat conductivity. They both depend upon the same characteristic data of the electrons. The formulæ for heat conductivity contain, in addition, the absolute temperature and the molecular gas constant. According to the law of Wiedemann-Franz, the relation between both conductivities is nearly constant and depends only upon the electron charge. This law holds for pure metals only and changes very much for alloys. The law holds with very minor exceptions for compound metals made by powder metallurgy.

Material Transfer

The making and breaking of contacts causes arcing under the conditions mentioned above under "Critical Current." Material transfer takes place from one contact to another during arcing, and the quantity of the transferred material is proportional to the current of the arc. It is found that in a short arc the fast primary electrons reach the anode, causing evaporation. In a long arc, with a great deal of ionisation in the medium, evaporation occurs at the cathode. The life of the arc as related to the speed of operation of the contacts determines the amount of evaporation of the metal.

Material transfer is a function of the electrical characteristics of the arc and, as just mentioned, is also a function of the physical properties of the contact material. Holm has shown that the unit loss in weight per coulomb depends upon the atomic volume of the metal, the characteristic arc voltage, and the hardness of the material. This point is most interesting, because it has been generally thought that the hardness of a contact was required only to prevent mechanical wear. But it is also a factor in the transfer of material, or, as it is generally called, "pitting."

The quantity of electricity passed during the life of the arc is determined by arc voltage, arc current, and the speed of operation of the contact. To determine the arc current, it is necessary to know the characteristic arc voltage as shown in Table II.

Table II.—*Material, Arc Voltage, and Weight Loss*

Material.	Characteristic arc voltage.	Specific weight loss, mgr./coulomb.
Carbon	18	0·0013
Aluminium	14	0·014
Nickel	14	0·02
Copper	12·3	0·045
Molybdenum ...	17	0·01
Silver	11·5	0·17
Tungsten	16	0·07
Platinum	16	0·13

The arc voltage and the specific weight lost per unit of electricity depend upon the contact material.

In the modern design of switchgear precautions are taken to prevent as much as possible material transfer by making the time of the arc as short as possible and the arc current as low as possible. In many cases condensers are placed across the contacts to diminish the arc voltage and current. In other cases the arc is extinguished by the use of oil, compressed air, or magnetic flux. In all cases the contact material with the best physical properties is recommended: First, for safety so that the switch or breaker will not suddenly go out of service; and secondly, for long life before replacement is necessary.

The Metallurgy of Contact Metals

Many demands are made upon a contact material, and the physical properties required of an ideal material cannot be found in any pure metal. Some of these requirements are that the contacts must not weld or stick during operation, must be hard, must not pit, and must have good electrical and heat conductivity. Silver and copper meet the conductivity requirements very well and are often used where the other requirements are not too important. On the other hand, tungsten and molybdenum with their great hardness and density are used where these requirements overbalance the conductivity needs. The ideal material for most contact purposes would be one which would have the hardness, density, and low material transfer of tungsten and the electrical and heat conductivity of silver. One might suppose at first that an alloy of two such metals would meet the requirements. Unfortunately, these groups of metals do not alloy, and, furthermore, alloys in general do not make good contact materials. However, powder metallurgy allows us to make compound metals which are satisfactory for contact purposes.

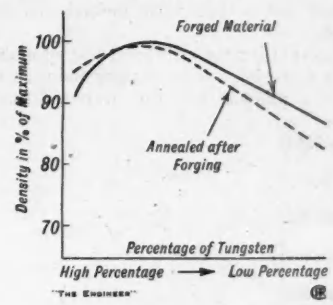

Fig. 3—Effect of Annealing

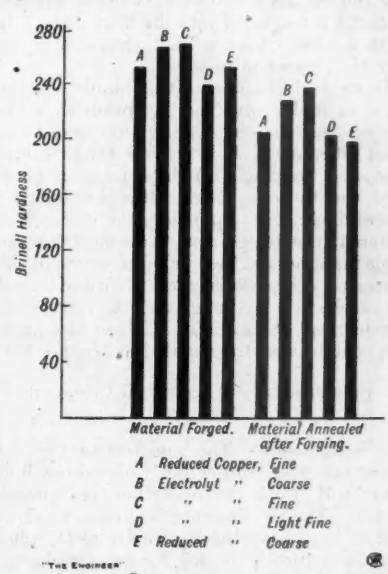

Fig. 4—Hardness of Copper-Tungsten Material

This method tends to combine the good conductivity of the silver-copper group with the other characteristics of the tungsten-molybdenum group. This phase of the development of contact materials has been studied for some time, and there are various methods by which such compounds can be made.

Three characteristic methods of producing such compound materials may be described; of course, variations of these are employed.

Method I is basically different from the other two. The starting material is a powdered hard metal, such as tungsten or molybdenum. This material is pressed into the desired shape and sintered, giving a body of the proper dimensions. It is then in the form of a sponge and the pores are filled by capillary attraction with melted silver or copper.

Method II is a very different way of making such a material. The starting point in this case is a mixture of two powdered metals

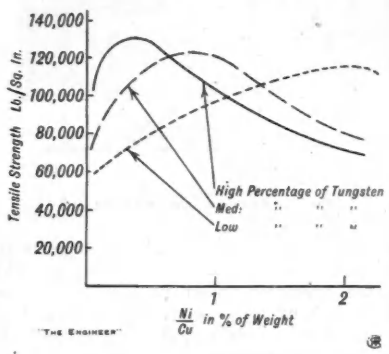

FIG. 5—STRENGTH OF NICKEL-COPPER-TUNGSTEN MATERIALS

such as tungsten and silver. These elements are pressed and pre-sintered at a relatively low temperature. After this operation the material is machined into the final shape. It is then sintered at a high temperature to give the correct properties.

In method III, the starting material is the same as in II, with the exception that the raw material may be initially processed somewhat differently. It is pressed, the pressure, of course, varying with the type of material used, usually being between 40 and 80 tons per square inch. After pressing, the compact is sintered, the temperature varying with the basic material and the final application of the material. The definite form is then obtained by mechanical working, such as repressing, hammering, or extruding. These last steps can be done with the metal either cold or hot.

Properties of Compound Contact Metals

Microstructure.—The microstructure of these materials shows fairly definitely how they will work in operation as contact metals. The chief science in producing these metals is to have the knowledge of (1) what microstructure is needed for certain characteristics and (2) how to influence the microstructure to obtain the desired characteristics. The type of powder used in the tungsten and molybdenum group has a very great effect on the microstructure and the characteristics of the final product. Micropictures shown in Fig. 2 illustrate a few examples of different types of materials that can be made; A shows a moly-silver compound metal of 60 per cent. molybdenum and 40 per cent. silver. The molybdenum particles show a slight preferred orientation in a plane perpendicular to the axis of applied pressure. The distribution in this compound is very uniform.

The following micrographs B and C show a tungsten-copper compound of 82 per cent. tungsten and 18 per cent. copper. Both specimens were pressed and sintered in the same way. The chief difference is in the size of the initial copper powder. B shows the material as made with fine electrolytic copper powder and C with coarse reduced copper powder. In studying these pictures it is easy to understand that the properties of the final materials are very different.

These materials were made to be used as contacts in oil circuit breakers. For air circuit breakers oxidation is detrimental, and it is preferred to use silver-tungsten compounds, as shown at D. The composition of this material is 90 per cent. tungsten and 10 per cent. silver.

Pictures E and F show a copper-nickel-tungsten compound material. For the preceding samples all sintering had been done below the melting point of the binder. In these two pictures the samples were etched by the same method; E was sintered below the melting point and F above the melting point. From the temperature at which the copper-nickel particles become alloyed by fusion, to the melting point of this alloy, very little change occurs. However, above the melting point the tungsten particles are dissolved by the liquid phase, and a very decided change takes place. It would seem that there are certain tungsten nuclei forming new large round grains.

This material has been developed for contacts operating at high currents, about 100,000 amperes. It has a density of over 17, which is sufficiently high for radium rays to be soon absorbed. It has a hardness of about 260–300 Brinell and a tensile strength of approximately 130,000 lb. per square inch. In spite of the high density and the hardness the material can be readily machined.

Density.—For contact purposes it is important to obtain a material with a density as near as possible to the theoretical. The density depends principally upon three things: composition, pressure, and heat treatment. It is well known that the higher the initial pressure, the higher the density of the compact; but in many cases there is an equalisation effect after sintering and mechanical working, which may offset to a great degree the importance of the initial pressing.

The density depends largely upon the heat treatment. Table III shows the influence of sintering time on density and shrinkage of a copper-nickel-tungsten material. By sintering for a sufficiently long time it is possible to obtain a density that is within 99 per cent. of the theoretical. In some cases sintering temperature can also influence the density. For example, the density of a copper-nickel compound was raised from 74 per cent. to 100 per cent. by increasing the temperature.

Experiments show that a second heat treatment after mechanical working can change the density. This change depends also upon the composition as well as on the heat treatment. Fig. 3 shows that annealing after forging can lower the density of a tungsten-silver compact when the percentage of tungsten is low and raise the density when the percentage of tungsten is high.

To arrive at a definite density from a two or three-component powder watch must be kept on the composition, the initial pressure, the sintering time, the sintering temperature, the mechanical treatment, and any subsequent heat treatments or annealing.

Hardness.—There is a definite relation between contact pressure and contact resistance, and therefore also of the heating of the contacts. Good contact materials therefore require a high hardness for this reason as well as those described previously. The hardness of a compound material is influenced in the same way as the density, *i.e.*, by composition, pressure, and heat treatment; in addition, there are other influencing factors. Fig. 4 shows the influence of different types of copper powder used in the mixture. A material with a composition of 82 per cent. tungsten and 18 per cent. copper was made with five different types of copper. The density did not vary materially—about ½ to 1 per cent. The electrical conductivity did not change more than 7 per cent. But the change in hardness, depending only upon the type of copper powder used, varied from 16 to 20 per cent. The powder not only varied in particle size, but also different types of copper were used, both reduced and electrolytic. When silver is used, the same difference in hardness is noted between amorphous and crystalline silver.

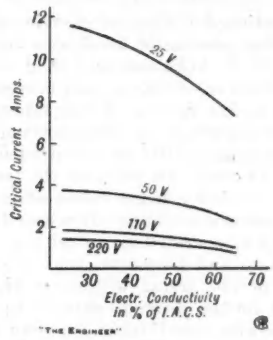

FIG. 6—CRITICAL CURRENTS FOR SILVER-TUNGSTEN COMPOUND

Tensile Strength.—The tensile strength is not as important as some of the other characteristics for contact materials, but it cannot be completely neglected. One can make several different compositions of copper-nickel-tungsten compound materials, all giving nearly equal tensile strengths (approximately 115,000–130,000 lb. per square inch). Fig. 5 shows curves of such compounds with high, medium, and low percentages of tungsten with varying nickel-copper percentages and their effect upon tensile strength. For all variations of tungsten, obtained by varying the nickel-copper content, there is about the same maximum tensile strength. While the same tensile strength can be obtained, other physical properties vary greatly.

Conductivity (Electrical and Thermal).—A definition of critical current and curves showing it for silver and tungsten have already been given. The critical current for a compound material lies between those of its components. Fig. 6 shows at various voltages the critical current for a silver-tungsten compound material as a function of the electrical conductivity.

Naturally, the most important physical properties for contact material are its thermal and electrical conductivities. These, as mentioned before, are a function of the electron properties of the metal. Therefore

TABLE III.—*Cu-Ni-W Compound Metal.—Influence of Sinter Time on Density and Shrinkage*

Sinter time in minutes... ...	1	.5	15	30	60	360
Linear shrinkage, per cent....	10	11·9	14·1	15·3	16·2	17·2
Density in percentage of max.	79·5	84·3	91·5	94	96·5	100

heat treatments changing the average electron velocity and the mean free path of electrons change the conductivity of the material.

There is a relationship between electrical conductivity and other physical properties. Fig. 7 shows the electrical conductivity of

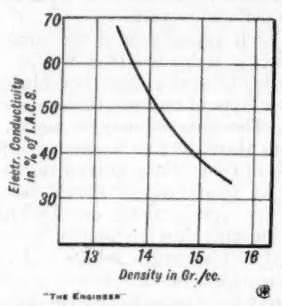

FIG. 7—VARIATION OF CONDUCTIVITY OF SILVER-TUNGSTEN COMPOUND WITH DENSITY

a tungsten-silver compound material *versus* density. The density in this case has been varied by changing the percentage of silver. A similar case is shown in Fig. 8, where the conductivity is shown *versus* hardness for the same materials. Slepian gives an approxi-

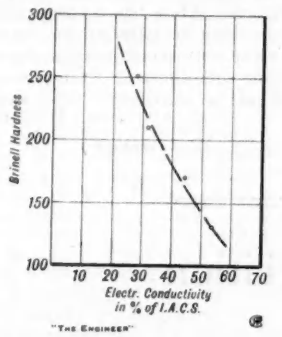

FIG. 8—VARIATION OF CONDUCTIVITY WITH HARDNESS

mate formula for the increase in temperature of contacts :—

$$T_z = \frac{E^2}{33 \cdot 5 \times R \times \lambda}$$

E—contact voltage,
R—electrical resistance,
λ—thermal conductivity.

This means that the rising of temperature is a function of the properties of electrons.

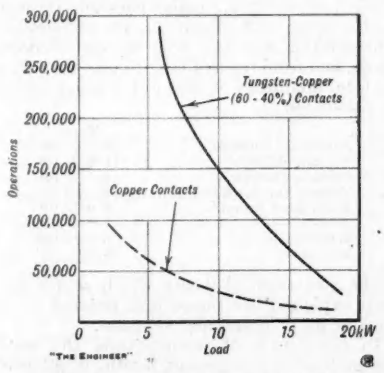

FIG. 9—LIVES OF TUNGSTEN-COPPER AND COPPER CONTACTS

Life.—All the properties mentioned above, *i.e.*, density, conductivity (both electrical and thermal), and hardness of a material determine the other properties essential for a good contact material. Besides the properties discussed, a good contact material must have no tendency to weld or stick, a minimum amount of burning and pitting, permanency of shape, and ease of brazing to the contact bodies. The compound contact materials, naturally, have a much longer life then either copper or silver. This subject has been very well covered in recent papers by G. Windred and K. Meier ; they state that experiments with a 60–40 per cent. tungsten-copper compound material used for the contacts of an oil circuit breaker show the life to be about six times as long as that for ordinary copper contacts. This is shown in Fig. 9, and, as can be seen, at 10 kW load the copper contacts gave approximately 30,000 operations, where the compound material gave 150,000 operations. These tests were made under identical operating conditions and the rate of switching was about sixty per hour.

At the beginning we discussed the demands for contact materials and have shown how these can be met by means of powder metallurgical products. Table IV shows some of the actual commercial compounds in use, which have met these requirements. There are densities from 10 to 17, electrical conductivities from 20 to 60, and hardnesses from 100 to 300 Brinell.

Arcing contacts, which require great resistance to wear, need a high density and have to be very hard. The conductivity is of secondary importance. Main contacts, on the other hand, require a material of high conductivity, while the hardness is not of such great importance. The increase in temperature of contacts made of compound materials follows the same laws as contacts made of pure metals. It depends upon the current, electrical resistance, and the heat conductivity. To meet the demands required of a specific contact problem, one can determine the material to be used having optimum characteristics for the application.

TABLE IV.—*Physical Properties of Elmet Contact Compound Metals*

Type.	Elmet 2 *h*.	Elmet 5 *k*.	Elmet 5 *d*.	Elmet 3 *c*.	Elmet 4.
Composition	Mo-Ag	W-Ag		W-Cu-Ni	
Density, gr./c.c.	10	13·2	15·2	10·3	17·2
Elect. conductivity, per cent. I.A.C.S.	50	59	38	25	20
Brinell hardness	120–135	105–115	170–190	190–205	245–300

Military Roads in the United States

No. I

AS a factor in the present emergency programme for war and national defence, the engineering and technical societies of the United States are occupying themselves with matters related to this programme and its problems, and as one definite result of its own activities in this direction the American Society of Civil Engineers has issued a report on military roads and road work in forward areas of military operations. This report, which is one of the Society's manuals of engineering practice, states that the studies and recommendations presented are based upon the theory that the problem of military roads in the theatre of operations is principally that of reconstruction and maintenance, although consideration of construction methods must be included.

For roads of this particular class the high standards of civilian alignment and surfacing are unnecessary, since modern military transport equipment can negotiate roads of a character formerly considered to be impassable for motor vehicles. In all military construction, speed is a prime essential, so that it is advisable to locate roads over and around natural obstacles, rather than to take the time required for refinement in alignment and gradients. But as speed of transport is limited by road surface conditions, roads connecting important traffic points should be maintained with a reasonably substantial and uniform surface.

Good base courses and fair wearing courses can be constructed entirely from such natural materials as crushed stone, gravel and sand. It is better, however, to supplement these with a manufactured binder. Such binders may be of Portland or natural cement or various bituminous materials. The use of cement for road and airport surfacing includes soil cement stabilisation, cement-bound macadam and concrete slab paving. Bituminous materials for roads include asphaltic road oils, road tar, cut-back asphalts and tars, asphalt emulsions, powdered asphalts and asphaltic cement. Methods for rapid maintenance of roads—paved and unpaved—are dependent largely upon the materials available, and where different materials are suitable the one most readily available should be selected.

Soil cement is a mixture of Portland cement, water and the natural soil as found in place, the soil being sometimes modified by adding gravel or crushed stone. Soils with excessive content of clay may be tempered with sand, or excessively sandy soils may be tempered with clay. But, as already stated, time is usually of prime importance in military construction, and as work built with cement requires about seven to fourteen days for curing, or before it can be utilised for traffic, such construction is used to a comparatively limited extent. With bituminous materials, however, the paving or surfacing can be opened to traffic as soon as its construction is completed.

Soil cement stabilised soils may form bases for surfacing or surface courses. A bituminous surface mat, ½in. to 1in. thick, would be necessary to prevent rapid surface deterioration and rutting under military traffic. Ordinarily, the proper mixture and proportions of soil, cement and water are determined by laboratory experimentation, but in emergency work this can be done roughly by field trial. In general, about 85 per cent. of all natural soils can be hardened by the addition of 15 per cent. or less of Portland cement, so that this percentage can be used in emergency. Conditions of optimum moisture and maximum density can be determined readily by a field laboratory.

The moisture condition may be described as damp, but not muddy. The depth of stabilisation for military use should be 6in., but not more.

In construction the first step is to scarify the road surface to a depth of 6in., pulverise the lumps and smooth the surface. The cement, in bags, is distributed along the road, dumped on the ground and spread by rakes or harrows. It is then dry mixed with the soil by means of ordinary heavy machinery, such as rotary tillers, spring-tooth cultivators, disc harrows or gang ploughs, the surface being then shaped by a road grader or blade machine. Water in the required amount is sprayed in increments of ½ gallon per square yard, the mixing operations being then repeated. The moistened mass is then compacted by plain and sheep's-foot rollers, after which the surface is covered with 2in. of soil or 4 lb. of hay or straw per square yard, to prevent rapid evaporation of moisture. This cover is left in place for seven days, being kept moist. After being opened to light traffic for one to four weeks, a bituminous mat is spread to a thickness of ¼in., or more. A prime coat of 0·2 gallon per square yard is followed by a seal coat of 0·3 gallon and 25 lb. to 30 lb. of stone chips per square yard. When this surface mat wears down to the treated soil it should be replaced with a similar or thicker mat.

An average condition calls for 10 per cent. of cement, by volume, and 12 per cent. moisture. For hasty construction, without laboratory control, but under experienced management, successful work may be done by using excess cement—say, 15 to 20 per cent.

Cement-macadam construction includes the following steps :—(1) Preparing the formation and setting the side forms ; (2) spreading and compacting the broken stone ; (3) applying the cement-sand grout ; (4) compacting the grouted mass ; (5) surface finishing ; (6) curing. The thickness may be from 6in. to 12in., with 8in. adequate for average civilian traffic and loads. The stone should not be spread more than 500ft. or 600ft. ahead of the grout. If the formation is soft, a first course of pebbles, coarse stone or slag may be rolled in to prevent loss of the macadam stone. The grout is proportioned one part of cement to two parts of sand, by weight, with enough water to make the grout flow readily and fill voids in the stone. Before grouting, the stone is compacted with a roller of 3 to 6 tons weight, or by the use of power vibrators. Hand tamping is of little effect. If uncrushed gravel is used it can be rolled only after grouting. Slag requires less rolling than stone.

As the grout is distributed, men with brooms spread it and work it into the stone. They are followed closely by men with a heavy template to tamp or ram the grouted mass to the proper level. Irregularities of more than a ¼in. under a straight edge 10ft. long are levelled by a 25 lb. hand tamper or by the larger template. As a finishing process the surface is smoothed with a long-handled wood float, 10in. wide and 3ft. long, followed by drawing over the surface a sheet of wet burlap. For curing, the road is covered with earth or straw or burlap, which is kept wet for two days, after which traffic is kept off for five days, during which time the covering is removed and the shoulders of the paving are brought up level with it.

Of concrete slab paving little need be said, as the construction of concrete roads is well understood. Its use in forward areas of military operations would be limited, since the finished concrete must be left to cure for from two days—if special cements are used—to fourteen days in ordinary construction.

Bituminous treatment and bituminous construction of road surfaces ranges from the application of a light coat to the construction of a layer or mat ¼in. to 3in. thick. Gravel is the material most generally used, but graded crushed stone with sand, or even sand alone, are often employed in work of this kind. For heavy mat surfacing, ¾in. to 3in. thick, gravel and sand, with clay or other binding material, are mixed with bituminous compositions to form a surface capable of carrying even heavy traffic in any weather. The gravel and bitumen may be mixed at the work or at a plant from which it is distributed to the work by motor lorries or other means. The mixture may be laid either hot or cold, and may be built up by successive applications from ¼in. to 2in. as traffic increases.

For road surfacing to be of practical value it must rest upon a stable base. Many old gravel roads are thick enough to serve this purpose, but on new formation there needs to be a sufficiently heavy base course before the surfacing or wearing course is applied. Either asphalt or tar may be used for the bituminous composition. Assuming that the existing gravel base is strong enough to carry the traffic, the construction of a road-mixed gravel-bituminous surfacing will be approximately as follows :—The base is trimmed and smoothed with a road grader, and when dry and free from dust or mud it is given a priming course of 0·1 gallon to 0·3 gallon per square yard, although in emergency this may be omitted. As traffic is not permitted over the prime coat, it may be applied to half the width of the road at a time. The gravel aggregate is distributed in a uniform row or windrow along one side of the road, and from this it is spread over the road surface in a layer of uniform thickness by a grading machine. Then the bituminous material is applied or sprayed by a distributor, a 1in. mat requiring about 100 lb. of gravel and 0·5 gallon to 0·8 gallon of the bitumen per square yard.

After each application of the composition the surfacing is bladed to a windrow along the middle of the road and then bladed back again to a layer of uniform thickness over the surface. The material may be moved in this way from three to five times for a finished thickness of 1½in. For a greater thickness the moving by road graders should be supplemented by spring-tooth or disc harrows. With the mixing thus completed the surfacing is shaped to the proper crown and contour. It is then rolled, but if rollers are not available it may be compacted by running loaded motor trucks or lorries up and down the road until their tyres have covered the entire area.

With the surfacing materials mixed at a central plant and delivered in place ready for rolling, there is the great advantage of minimum interference with traffic. Cold-mix material may also be deposited along the side of the road for future use in repair and maintenance. While the mixing under this system is done usually at an established plant within convenient haulage distance, it is also done sometimes at a temporary plant installed on a convenient site along the road.

(To be continued)

British Association

No. IV

(Continued from page 140, August 14th)

The Dead Sea and its Surroundings, by Dr. Ernst Bergmann

THE Dead Sea has attracted for many years the interest of geologists and chemists and has already played since 1930 a modest *rôle* in the supply of its three most important constituents, potassium salts, magnesium salts, and bromine. With the outbreak of this war its importance has suddenly grown considerably, as the main previous production centres of these three vital materials are now in Axis hands. The Dead Sea is now the only source of those commodities in concentrated form within the British Empire. Its possession has become of political and strategical importance, and it therefore deserves a brief description and a discussion of its future possibilities in the frame of a conference on mineral resources and the Atlantic Charter.

From the original reservoir of potassium salts, namely, the silicate layer of the solid earth surface, which consists of 2·4 per cent. of potassium, the potassium salts have been swept gradually by the rain into the rivers and from there into the sea. Together with the other solubilised salts, namely, sodium, magnesium and calcium, they have therefore accumulated wherever parts of the sea or inland lakes have evaporated. Such a process has occurred in vast dimensions in Central Europe, and has left its trail in the originally cohering salts deposits of France, Poland, and Central Germany.

The process itself is still in constant operation at the Dead Sea in Palestine, where on a surface of 47 miles length and 9 miles average breadth, through an absorption of solar energy, of 630 calories per square centimetre and per day of twelve hours, evaporation of water takes place.

The water, by absorption of heat energy, increases its temperature considerably over and above the air temperature ; a particular observation records a water temperature of 62 deg. Cent. on a day with an air temperature of 37 deg. Cent. ; thus the evaporation becomes about 250 per cent. more efficient than on the —already favourable—shores of the Mediterranean.

The water and the salts are supplied by the Jordan and some other minor tributaries of the Dead Sea which increase the amount of water and bring with them a quantity of 40,000 tons of potassium chloride per annum. While the ratio of the various salts remains constant throughout the depth of the Dead Sea, the absolute salt concentration increases from the surface downwards, and from the available figures the following total quantities of salts in the Dead Sea can be calculated :—

	Tons.
Potassium chloride	2×10^9
Sodium chloride	$11{\cdot}9 \times 10^9$
Calcium chloride	6×10^9
Magnesium chloride	22×10^9
Magnesium bromide	$0{\cdot}98 \times 10^9$
Magnesium	$5{\cdot}8 \times 10^9$
Bromine...	$0{\cdot}85 \times 10^9$

The two main elements which so far have been exploited are potassium, isolated in the form of its chloride, and bromine.

In the course of manufacture, the water, drawn from a convenient depth, is subjected to fractionate evaporation in natural pans, which have an impervious clay bottom. First, sodium chloride (common salt) crystallises, then a somewhat impure artificial canallite—a double salt of potassium chloride and magnesium chloride—which in a natural form is also the starting material for the potassium chloride in the European mines, and finally magnesium chloride crystallises. The mother liquors go to the bromine producing plant. By an ingenious

application of the solid-liquid equilibria of the salts concerned, highly purified potassium chloride is ultimately produced.

From the point of view of rational structure of the world industry, it must be considered very unsatisfactory that none of the other technically important potassium compounds is manufactured in Palestine.

Potassium salts are of vital importance for war effort. Not only that chemical industry is unthinkable without potassium hydroxide, not only that potassium chlorate has its uses in the explosives industry—if it is true that food is an ammunition of war, fertilisers are essential raw materials for such ammunition.

One of the most interesting constituents of the Dead Sea are the nearly 1000 million tons of bromine, which is the largest quantity found at any single place in the world. Even Germany possesses only a total quantity of $0 \cdot 12 \times 10^9$ tons bromine, *i.e.*, a seventh of the quantity accumulated in the Dead Sea. It is therefore not astonishing that the Palestine Potash Company is to-day the biggest bromine producer of the world. Nature has in Palestine achieved a concentration of bromine which the chemical industry in America (and, I believe, in this country also) is trying to achieve.

The third constituent of the Dead Sea which deserves closer attention is the magnesium, which we have seen to occur in the Dead Sea to an extent of 5,800,000,000 tons.

All these considerations taken together tend to show that the Dead Sea may become a source of industrial life perhaps unequalled by any other natural concentration of mineral wealth.

I may be allowed to stress the rather superficial analogy that Nature has also provided some elementary form of energy which could be utilised for the exploitation of the Dead Sea. In general, for geochemical reasons, potassium deposits are connected with oil deposits quite naturally, as oil originates from the decomposition of a maritime flora and fauna. Whether oil is to be found in the immediate vicinity of the Dead Sea has not yet been explored, but it has been known for a long time that the mountains separating Judæa from the Dead Sea consist to a large extent of a bituminous limestone. Approximately 24,000,000 tons of this stone are available, containing up to 20 per cent. organic matter and giving a destructive distillation up to 11 per cent. of its weight in the form of a shale oil which could be used to generate the power and to form the fuel required for the prospective development of the Dead Sea.

Together with this oil, which has a thermal value of 18,000 B.Th.U. per pound, a gas is formed in a quantity of 27 cubic metres per ton and with a calorific value of 800 B.Th.U. per cubic foot. One ton of limestone would therefore give about 25 therms.

From the point of view of inorganic heavy industry, it is not uninteresting that the shale oil contains about 10 per cent. of sulphur in form of organic compounds, which can easily be desulphurised. The sulphur thus liberated can become the source of the sulphuric acid which will be required in the production of the most important potassium fertiliser, viz., the sulphate from the potassium chloride of the Dead Sea.

In this respect it may be mentioned that in the Gaza area in the south of Palestine a large sulphur deposit has been discovered, representing, according to an approximate evaluation, at least 1,000,000 tons of sulphur, so that all the sulphuric acid required in the production of potassium sulphate could be made from local raw material.

Another industrial possibility also offers itself. If potassium sulphate is manufactured, large quantities of hydrochloric acid will become available, which in general is considered an undesirable and noxious waste product of the chemical industry. But there is one process in which hydrochloric acid is advantageously used, namely, the conversion of phosphate rocks into fertiliser phosphates. Phosphate rocks, tertiary calcium phosphate, are so insoluble that they cannot be absorbed by the capillaries of plant roots. The secondary calcium phosphate, however, is soluble enough, and the conversion can be carried out by means of hydrochloric acid. The Transjordanian shore of the Dead Sea has considerable phosphate deposits and also on the Palestinian side large deposits have been studied representing a somewhat less concentrated tricalcium phosphate, namely, of 43 to 56 per cent.

Economy in the Use of Ferro-alloys, by Dr. W. H. Hatfield, F.R.S.

In times of peace, particularly if they are of long duration, the qualities and characteristics of that which is produced are the result of tradition and usage, salesmanship, and the developments due to technical progress based on the application of old or new knowledge. Tradition, usage, and salesmanship slow up in measure the inevitable progress towards the realistic efficiency possible through knowledge and the consolidation of technical progress. War and preparation for war insists upon stark efficient realism, and those who prepare for war are given more time to attain to it than those who are unexpectedly called upon to face such conditions. Also, in times of peace, international trade throws open to all countries the world's resources in raw materials and facilities on an economic basis; war rudely disturbs this state of things and realism in production must then deal with a limited or changed availability of that upon which production can continue.

These conditions apply at the moment to the production of steel, and particularly to special and alloy steels. Concerted efforts are being made within the industry to attain maximum efficiency based on the availability and changing availability of raw materials and facilities. It will be obvious that technology and technique so developed can be, and will be, projected with advantage into post-war times.

What has been done as regards the metallurgy of steel, particularly as regards special and alloy steels? In May, 1940, the Special and Alloy Steels Committee constituted its Technical Advisory Committee with a mandate to deal with this problem. It was found that the production of the steels was governed by between two and three thousand specifications. The first step was therefore a meticulous study which resulted in the sorting out of the whole of the steels covered by the specifications, into eighty-five categories essentially upon the basis of mechanical properties, compositions, or special functions. The T.A.C. Schedule 1 to 85 did not lend itself to general publication, since it was all-embracive, but it permitted the appropriate authorities and individuals to survey the interesting position thus disclosed.

The main point achieved was that it became possible to measure up needs against availability as regards the essential alloying elements. Means were found by the Steel Control, assisted by the goodwill of the industry and the consumers, to accommodate manufacture with quite reasonable success to changing conditions. Steel conditions change, but in the truly indigenous British manner of adaptation to changing circumstance, the means of adaptation now exists which, it may be presumed, will achieve as much as is possible according to the existing conditions and needs of the moment.

The T.A.C. Schedule of eighty-five categories for so many specifications was possible, owing largely to the manner in which the same object was being achieved by different or slightly different compositions and treatments. Thus, as will be described, selection was possible of a relatively few appropriate compositions and treatments to facilitate mass production, but at the same time alternative steels became scheduled, and so material guidance exists for change with availability as the need arises. How far can results be achieved without alloy conditions? How far can we replace nickel with chromium or chromium with nickel? How and in what circumstances are molybdenum and vanadium essential? Can we replace tungsten with molybdenum or molybdenum with tungsten? Will a modified heat treatment with a different composition give the same characteristics? A survey of the categories of the schedule assists in answering some of these questions.

In 1941 advantage was taken of the existence of the British Standards Institution to issue document B.S. 970—1941, giving in the form of fifty-eight specifications the principal and most useful of the steels in the schedule covering wrought special and alloy steels for general engineering purposes in dimensions up to 6in. ruling section. This document was shortly followed by B.S. 971, which implemented the contents of B.S. 970—1941, with much technical and other useful data facilitating the successful application of the selected steels. This document sets a precedent in form. At this stage the Steel Controller issued a Direction through the British Standards Institution B.S. 970A, indicating that in conformity with existing conditions, certain steels specified in B.S. 970—1941 should, in the absence of special sanctions, be the steels applied in future programmes. Thus the "En Series" of war steels entered their useful career. On March 30th, 1942, a brochure was issued indexing and correlating the great mass of specifications to the steels of the Direction 970A, which sought to replace them. Two remaining steps should be mentioned. B.S. 970—1941 was revised and is reissued as B.S. 970—1942, and representatives of all the Services, after deliberation upon the steps already taken, issued through the British Standards Institution document B.S. STA 5, which co-ordinates the whole of the requirements of the Services within the terms of reference with the composition and properties of the steels of the Direction on the basis of the En Series contained in B.S. 970—1942.

This successful collective effort at unification has only been possible as a result of the firm determination of all parties to attain that which was intended. Finality under present changing circumstances is not possible, but succeeding documents under the ægis of the same authorities will, it is hoped, successfully keep up to date such essential data.

The problem is a considerable one, namely, how at the present time to cater for a greatly increasing demand for steels of the necessary properties with a changing availability and a considerable deficiency in some of the essential elements. Never has a more interesting technical situation developed for solution by scientific and technical minds.

Autocracy in science or technology is as deadly as in the political field. In these efforts within the steel industry, our work is being advanced by the friendly and enthusiastic collaboration of many minds. The co-ordination of different points of view has resulted in, and is operating, a workable procedure. Stark efficient realism is necessarily our theme.

(To be continued)

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

WAR EMERGENCY ELECTRICAL WIRING INSTALLATIONS

It was recently announced that a War Emergency Code of Practice for Electrical Wiring Installations had been prepared by the Institution of Electrical Engineers on behalf of the Codes of Practice Standardisation Committee, set up under the authority of the Ministry of Works and Planning. This Code of Practice has now been published as a War Emergency British Standard, together with a series of specifications for various types of installation. The series at present consists of the following documents:—B.S. 1062, Code of Practice for the Planning of Electric Wiring Installations; B.S. 1063, Specification for Wiring on Cleats; B.S. 1064, Specification for Wiring in Conduit; B.S. 1065, Specification for Outdoor Distribution Systems; B.S. 1066, Specification for Bell and Alarm Systems. In the preparation of these documents the primary object has been the reduction of material and labour costs to a minimum. The adoption of some of the provisions of the Code will entail a degree of risk which would not be accepted in normal times, and the life of the installations will be considerably reduced, a period of not less than three years being the "target" life. These British Standards are intended to be used as a basis for all war emergency electrical work, whether in permanent, semi-permanent, or temporary buildings. In cases where special conditions have to be met or where risks have to be taken, *e.g.*, in danger buildings, previous standards should be followed. Copies of these five standards are obtainable at 1s. 3d. each post free.

The Engineer

AUGUST 21, 1942

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Telegraphic Address: "Engineer Newspaper, Estrand, London." Telephone: CENtral 6565 (10 lines).

ENGINEERS IN THE ARMY

IN 1923 Lord Weir recommended that all the mechanical engineers in the many corps or branches of the Army should be amalgamated and incorporated in the corps of the Royal Engineers, which, in any country less illogical than ours, would be taken to mean the engineers to the Army. His advice was not followed. Some five or six years later, Lord Milne, when Chief of the General Staff, presided over a committee to consider a similar proposition, of which he himself was in favour. The proposal was again rejected, largely no doubt because the Army Council had no senior engineer who could advise it regarding the implications of such a momentous change. Hence, when preparations were made in earnest for a mechanical war which could be averted only by a miracle, the Army found itself without a unified engineering organisation, and with no mechanical engineer in a sufficiently high position to give the necessary authoritative advice direct to the Army Council. No doubt Lord Weir foresaw this difficulty in 1923, and it is safe to state that had his advice been accepted then, it would not have been necessary for Sir Ronald Charles to deplore, as he did in a recent letter to *The Times*, the great paucity of the engineering staff at his disposal when he was Master-General of Ordnance at the War Office.

From debates in Parliament it is obvious that Members of both Houses have felt uneasy that engineers and scientists are not being utilised to the best advantage by the Army, and as shown in our leading article on this subject in our issue of June 12th, it is clear that the Army has lagged far behind in granting recognition to the overwhelmingly increased importance of engineering in general and its engineers in particular. Had it been more receptive of this new idea, the lead we had in aggressive tank warfare in 1918 might well have been maintained twenty years later when the present world war began. Entirely new mechanised equipment was clearly a very expensive item in rearmament, and doubtless Hitler traded on the fact that his potential opponents throughout Europe would be chary of laying down sufficient sums of money to counter his expenditure on Panzer troops. In the very early days of warfare, the soldier was fairly well self-contained. Given his food and drink, the weapon in his hand was his main standby. As, however, time passed, more and more did he become dependent on fresh supplies sent up from some base to replenish the ever-growing weight of missiles being launched by him and to make good the wastage of his heavy equipment in the course of battle. Thus the engineering problems have increased out of all knowledge, but the recognition of the importance of the engineer has not kept pace with the desired provision, nor has he been given the requisite status to enable him to pull his full weight in the time available. Apart from the soldiers whose principal duty is to fight in the front line—cavalry, armoured corps, infantry—there are many other corps in the Army—Royal Engineers, Signals, R.A.S.C., R.A.M.C., R.A.O.C., and now the recently formed R.E.M.E., a corps which it has taken twenty years of consideration and three years of war to force into existence. The heads of these Corps are only Major-Generals, except in the case of the R.A.M.C., whose head is a Lieutenant-General, with many Major-Generals to support him for strictly corps duties. We may well ask why the R.A.M.C. is singled out for such an honour? Is it because the power of the British Medical Association, speaking with one voice, has ensured a just position for members of its profession, whereas there has never been one engineering voice to bring home the essential importance of that profession? We acknowledge the pressing need of medical science in war, for many an earlier campaign has been lost by disease rather than by force of arms, whereas in the wars of this century our troops have been kept in wonderful health and heart, thanks to the preventive watchfulness of our medical organisation. Although its senior officers do not command fighting troops in the field, we agree that the ranks of the R.A.M.C. are fully justified. It must be pointed out, however, that the labours of that Corps are largely defensive in object—to prevent losses and retrieve casualties. Is there not a pressing need to assemble the engineers to force the offensive?

We do not yet know exactly what is envisaged as the final *rôle* of the R.E.M.E., but welcome as is this step of forming a new Corps, it will hardly meet the needs of a mechanised Army if it is to be concerned solely with repairs and maintenance. There are higher responsibilities which could and should be placed upon it, such as the provision and training of mechanical engineers for design, test, and investigation. We trust that even if its head is only to be a Major-General, as is the case of the other and older corps, preparations are in hand to make a post or posts external to the Corps, with a higher rank to which in due course the most senior mechanical engineer can be promoted, and in which he can give advice with a broad outlook, on the same level of seniority and with the same measure of authority as a member of the Army Council. Until such a step is taken we fear that mechanical engineering on which the offensive needs and spirit of our Army depend so greatly, will not come by its own, for why should the cream of our young engineers seek to join a service which is neither sufficiently consulted nor honoured?

Colour

WHEN Shakespeare inspired Bassanio to exclaim:

> "So may the outward shows be least themselves:
> The world is still deceiv'd with ornament,"

he was evidently conscious of a state that is never likely wholly to be eradicated, but there is another side to the picture as expressed in the sentiment that "to win the eye is to win all," and between these two ideas may be found a useful avenue for exploration. Nature herself goes to considerable pains to make use of the attractions of colour, in some cases the purpose is evident, in others it is harder to understand; even as the most gaudily painted butterfly may fold its wings and suddenly become drab and colourless, so colour may with advantage have its place in the industrial world, even if it has to be hidden when its display might attract the unwanted attention of the enemy.

If colour has a definite effect on human psychology—as it undoubtedly has—we do well to ascertain what that effect is, and, having determined it, make use of it in such a way as to increase production. A few simple illustrations might be cited: the Firth of Clyde probably experiences more than its share of grey skies and mist, and this gloom has a depressing effect on the spirits of the tourists to its shores, but it is instructive to recall how the appearance of the well-known R.M.S. "Columba"—now, alas, no more—with her two red funnels, immediately seemed to introduce an atmosphere of warmth and hope. Again, how many of us have troubled to appreciate the wisdom

of the choice of colour for our familiar London buses? We should not like to face the thought of the same vehicles in a livery of sombre grey! Or, yet again, the old railway managements vied with one another in producing smart locomotives of distinctive hue, so that Carlisle or York stations were able to display some wonderful colour effects, with half-a-dozen or so different railways using the same station. Nor was this wasted effort, for the reputation of British railways was enhanced thereby, and there was favourable comment in far distant lands—a definite business asset. In days of austerity, when there is perforce much to depress the spirits of most of us, we may legitimately wonder whether it would not have been a wise policy to keep our rolling stock—locomotives and carriages—smart and of pleasing appearance. Anything that savours of neglect is painful to the engineer. The psychological influence of colour on the happiness of human beings has been admitted, and in spite of the grimness of total war, the female worker has insisted on maintaining the display of colour in the workshop, and the results have been all to the good. Too often really attractive schemes have been spoiled by their unattractive presentation. A few enlightened managements have set to work to eliminate the sombre grey hues from the workshops they control, even going so far, after having decided to paint the machine tools in arresting colours, as to introduce different colours for different types of machines and plant. A brighter atmosphere in the works has been the result, and it is not surprising to learn that the output has increased. The effect that a careful choice of colour exercises on the illumination of the workshop has not been explored as fully as is warranted, yet most people realise that certain colours have a subtle influence in promoting feelings of chilliness or warmth, of happiness or depression. It is of the utmost importance to select for the walls and partitions in factories just those colours that will best suit local conditions, with regard to diffusion of light and the nature of the work. To paint the walls of a foundry or forge a brilliant vermilion would not tend to promote an increased effort on the part of the employees or to improve the efficiency of the staff. What applies to the shops applies also, but perhaps in an even greater degree, to the canteen and the rest room. Many firms have provided excellent facilities for meals and recreation, and yet at the same time have paid little or no attention to ensuring an attractive colour scheme which would make all the difference to the feelings of the user. Most of the publicity posters now appearing as an incentive to a greater productive effort are commendably artistic, and if suitably mounted have a distinctly decorative effect in the works canteen, thereby serving a dual purpose. Offices often need similar attention, and carefully selected colouring relieved by pictures which may be both attractive and, at the same time, have an advertisement value, leads to a remarkable transformation. Colour is not used nearly enough as a distinguishing sign, yet it is a very effective method of showing at a glance whether a gauge is intended for manufacturing or inspection purposes, what nature of steel or alloy is being used in the tool-box, or even whether an article has passed inspection or stands rejected. In days of yore the foreman was known from one end of the shop to the other by his bowler hat, he was truly the "monarch of all he surveyed." Then came functional management, and other modifications leading to divided control so that at the present time it is no easy matter to spot the various executives. Here again colour comes to the rescue, and already some undertakings have found that it adds to efficiency and that much time is saved by issuing armlets of different colours to different officials; the Government Inspector is readily distinguished from the company's own examiners, and the tool setter from both of them. Time is saved and vexation obviated.

Need more be said to show that colour can be used by the engineer to an almost limitless extent as a valuable ally. Something has already been attempted, something done, but only the fringe of the subject has been touched. There may well be unsuspected potentialities in colour schemes in the factory.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

ENGINEERING EDUCATION

SIR,—I have read with interest the review of the memorandum of the Institution of Civil Engineers given in THE ENGINEER of July 17th, and your editorial comments in the issue of July 24th. I have long been interested in the problem of engineering education, and believe my contribution to the general discussion which you mention in your Editorial is of some interest.

The whole question of engineering education is linked with the functions which engineers are called upon to perform. It is my considered opinion that the present practice of industry being controlled by non-technical personnel is one of the major causes of the tendency of this country having a relatively disadvantageous position, both in war and in peace. This condition is apparently unavoidable so long as only specialists are available. If, in the future, it is proposed, as is seriously being suggested, to establish some form of close national control, if not management, of industry, the necessity of having available the appropriate technical personnel who will be able to make the major decisions, in effect on behalf of the nation, becomes a matter virtually of life and death to the people of this country. Experience has shown that a committee of "experts" presided over by a non-technical person is not capable of yielding the results required by the present conditions.

In my opinion, therefore, it is clear from experience that under the term "engineer" there should be recognised three definite groups—namely, engineers as such, engineer technicians, and engineer tradesmen.

The last of the groups includes all who actually work with their hands, *i.e.*, fitters, turners, wiremen, welders, and the other multitudinous skilled and semi-skilled trades now required in the engineering industries. The education and training of this group is not here considered.

The term "engineer technician" is used here to cover the majority of engineers who specialise in any one particular branch, such as are at present described by the terms "electrical engineer," "mechanical engineer," "hydraulic engineer," or "automotive engineer," and who fulfil the functions of designers, sales engineers, shops superintendents, power station engineers, and the like.

The term "engineer" is here used to cover one who is familiar with the theory and practice of all the sections within the scope of his branch. In my opinion, there are virtually only two branches, namely, machine engineering and civil engineering. The machine engineer should be competent to come to decisions on the design, application, and manufacture as well as the commercial and economic problems in connection with all types of machines and electric equipment, whether the machine be an electric motor, radio set, or an aeroplane engine.

The functions of a civil engineer would be similar, but applied to all structures, works, canals, roads, and railways, whether above or below ground or on the sea or in the air.

The status of the appropriate grades should be protected to prevent such statements as "girls trained as engineers in six weeks" being made by Government Departments or the Press. Public opinion and the law does not tolerate a V.A.D. being called a doctor (medical practitioner). Why, then, should a girl machine operator be called an engineer?

The title of engineer should be reserved for the highest grade, and specialists should have their own titles, such as electrician or mechanic. At the same time steps should be taken to prevent the misuse of these titles by tradesmen, such as wiremen or fitters. This is enforced in the medical and legal professions. Why, then, should engineers not have their status recognised? Such status should be available as soon as the necessary qualifications have been attained, as in the instance of the medical profession.

The training of engineers in the sense here used is of major importance to the nation as a whole. They must have the widest possible basis for coming to their decisions. They should therefore be recruited from persons who have received a most thorough grounding in what used to be termed the "humanities," *i.e.*, have a classical general education to the Higher School Certificate or Matriculation standard. In this connection I can but endorse the suggestion put forward by the Institution of Civil Engineers. This must be followed by a university education in science, including mathematics, to the pre-war Tripos standard of Cambridge University, but including geometric drawing; as well as applied mathematics (mechanics), including strength of materials; physics, covering optics, acoustics, electricity and magnetism, hydraulics, aerodynamics and thermodynamics; chemistry, covering the organic and inorganic branches, metallurgy, and geology; sociology, including economic history, ethics, principles of economics, politics, social economy, banking, company law, and accountancy; and, finally, two languages, one of which should be German, all being taken to the accepted University Honours Degree standard.

The partially trained engineer would then proceed to one year of practical work, and then to a further two years in a technical college, covering a course appropriate to whether he should become a machine engineer or civil engineer. The course for machine engineer and

civil engineer would be respectively as follows:

Machine Engineer.	*Civil Engineer.*
Machine design, construction and drawing.	Structural design and structural drawing.
Electrical machine design.	Electric technology.
Hydraulic machine design.	Machine technology.
Aerodynamic machine design.	Instrument technology.
Surveying.	Surveying.
Instrument design.	Bookkeeping and costing.
Bookkeeping and costing.	Structural practice, including price fixing and processing.
Workshop practice, including processing and price fixing.	Structural architecture.
Structural technology.	Naval architecture.
Mining technology.	Mining and quarrying and traction.
Traction technology.	

The training would be completed by a further year of practical training. The formal instruction would then be finished, and the young engineer would be ready to start acquiring the necessary experience to fit him for the highest administrative posts.

It is suggested that the granting of degrees by universities on a basis of technological training should be discontinued as being incompatible with the conception of a "university." The function of technical training should be relegated to technical colleges.

It will be observed that the training of engineers as such will take approximately seven years, terminating at the age of twenty-five plus, provided the student has gone through the courses without a hitch.

The training of technicians would be performed by technical colleges, the course being much the same as pursued at present at most universities and technical colleges; preceded and followed by one year's practical training. The total time occupied would be approximately five years. The standard of the general education need not be as high as in the instance of engineers, so that the training could be completed by the age of twenty-two plus.

It may be contended that the training of engineers is unduly protracted, and that the young men will be deprived of the necessary experience of handling their own affairs until too late an age. This is avoidable, as during the practical training a living wage can and is paid. Further, on proceeding to the technical college, the engineering students will already have a knowledge of science much higher than that required by the technicians. They will therefore be in a position to tutor the technical students passing through the college in the scientific subjects they have already studied. They could receive the normal salary for such work which would be amply sufficient for their living needs and make them financially independent of their families on completing the university course, to the same extent as is the practice at present. This procedure would have the additional advantage of ensuring that the engineer is capable of passing on his knowledge and of co-operating with any technicians on whom he will have to rely in his future work.

To overcome the difficulty of persons in later life having the knowledge to obtain the qualification of engineer and wishing to do so, provision should be made for facilities for them to sit for the university degree examination externally, provided that they can show the attainment of the same general educational, *i.e.*, cultural, standard, as the entrants to the university.

Having made available the personnel of the necessary training, steps should be taken to ensure that certain appointments should be restricted; thus the position of chief engineer, managing director, works manager, as well as sales manager or the equivalent positions of an engineering enterprise, should be occupied by an engineer in the limited sense here used. Apart from the highest administrative appointments, certain others should be reserved for engineers; thus persons responsible for the selection of plant to be installed should always be engineers, whether the person is employed by the manufacturer or user on their own staff or as a consultant. Further, the minimum salaries paid should be established so as to prevent the misuse of material valuable to the nation. The enforcement of the selection of plant by engineers could easily be done by the insurance companies requiring a certificate to this effect.

The difficulty of restricting the title of engineer is appreciated, but the time has now passed wherein we can afford the luxury of calling things by wrong names. The nomenclature should be brought up to date, since it is now generally recognised that while a person working with his hands may have been an engineer in the time of Stephenson or Watt, he definitely is not so now, and that even a technically trained person with a narrow speciality is not an engineer.

The tendency to specialisation is not so pronounced in civil engineering as in machine engineering, and it is therefore not surprising that the Institution of Civil Engineers should have overlooked the condition already existing in machine engineering. The tendency is already apparent, and that the evolution in the same direction is inevitable, even in civil engineering, is clear. It is therefore essential that both branches should be put on the same footing.

The last question is the future of the great engineering institutions. The Institution of Civil Engineers should remain much as at present. It is interesting to note that the memorandum published already shows the necessity of making grades available for narrow specialists. For the machine engineering branch it would seem inevitable that the two Institutions of Mechanical and Electrical Engineering should amalgamate to form the Institution of Machine Engineering. The grade of "fellow" and "member" being reserved for engineers in the present sense here used, and subsidiary grades being available for narrow specialists; thus hydraulic, mechanical, electrical, aerodynamic, and any other sections would be available with their appropriate grades, say, of "associate" and "constituent." The amalgamation of the two parent bodies would give an opportunity of modifying the Charter to allow the protection of the status of the participants in the Institution. The introduction of similar modifications into the Charter of the Institution of Civil Engineers would then be easier.

The great Institutions would thus occupy much the same position towards the engineering profession as the Medical Association and Council bears towards the medical profession, and would, in addition, protect the position of engineers. The latter provision is essential, since engineers and technicians are, by the very nature of their work, mostly employees, and their work does not lend itself to the establishment of individual business, except, of course, as consultants.

The proposed rationalisation of the engineering profession would inevitably have a deep effect on the national position, since it would enable engineers to exercise the influence they should, and at present do not, exercise, since they have not the necessary status for their opinions to be accepted, either by the public or the administration of the country.

N. V. Pestereff,
Associate Manchester College of Technology; Member of the Association of Mining, Electrical and Mechanical Engineers.

Edinburgh, August 6th.

DIVE-BOMBING

Sir,—The limitations on the effectiveness of dive-bombing are evidently not very widely appreciated.

Bombing from a vertical dive provides a "no allowance" shot at a target on the vertical dive path extended to the earth's surface.

The vertical dive is for many reasons not a practical manœuvre on existing types of military aircraft.

Bombing from a 70 deg. dive—which is about as near vertical as is practicable—is not merely not a "no allowance" condition, but one in which accurate bomb aiming is impossible, unless the release of the bomb is delayed until the aircraft is so close to the target that the divergence of bomb path from the flight path produced is small. But to get into a 70 deg. dive at 1000ft. to 2000ft. above the target, reasonably accurately aimed at that target, the dive must be started from some considerably greater height. Owing to the fact that projectiles from A.A. guns—and even small-bore machine guns—have a muzzle velocity very high compared with the velocity of a bomb falling from the dive-bomber's normal bombing height, the aircraft during its whole dive presents a target for whose motion very little allowance has to be made.

Hence, against any target with reasonable A.A. defence, even if this be only of the machine gun category, whose gunners are well trained and will hold their fire until the bomber is down to, say, 3000ft., the dive-bomber is an easy target, and should rarely escape being shot down.

Against untrained or panic-stricken defenders it is a potent weapon, but there is ample evidence that even rifle fire from well-trained men is often sufficient to put the dive-bomber out of action, and evidence that against prepared troops and reasonable A.A. defences it is an expensive and futile weapon. High-level bombing by well-trained bomb aimers is far more effective and far less costly.

In the case of attack on ships of war under way, the position is rather different. If it is of sufficient importance to destroy a warship in a limited time and the cost in attacking aircraft is relatively unimportant, dive-bombing may be a justifiable form of attack. It should be very costly to the attackers, but if the pilots are sufficiently determined and numerous, one or more will get home on the target—if not to his base.

W. H. Sayers.
Wolverhampton, August 12th.

FRENCH LOCOMOTIVE PERFORMANCE

Sir,—The correspondence arising from my articles in your issues of February 6th and February 13th, 1942, has now covered a wide field. It began with comment upon the apparently inefficient way in which the Nord drivers handled the Collin "Super-Pacifics"; and the wire-drawing effects subsequently quoted as a probable reason for the use of a high-pressure cut-off not much less than 40 per cent. brought forth some mild criticism of the front end design. From that beginning the correspondence somewhat inevitably swung towards a discussion of the relative merits of compound and simple propulsion, in which discussion the rebuilt Chapelon 4–6–2s and 4–8–0s have been quoted often. I am only sorry that I have no footplate experiences of either class in ordinary service, with which to supplement various items of test data quoted in this correspondence; one often finds that drivers' methods are at variance with "the book," as a result of continual experience of their locomotives, and such variations can throw many an interesting sidelight upon the performance characteristics of the classes in question.

The correspondence in its later stages has moved away from the locomotives to which the original articles related, though, as Mr. C. M. Keiller points out in his letter published in your issue of July 24th, the design of the Chapelon 4–8–0 boiler owes its origin to the success of the Collin 4–6–2s. The P.O.-Midi rebuilt 4–6–2s

and 4–8–0s represent so substantial an advance in locomotive engineering practice that to refer to them merely as developments of the De Glehn system is to belittle Chapelon's work. His researches, and the extraordinarily successful application of the results, mark the beginning of a new chapter, just as definitely as the Collin 4–6–2s mark the end of what may be called the pre-Chapelon era. It was as a farewell tribute to this past era that I originally wrote of my experiences on the Nord 4–6–2s, and in view of the performance data of Chapelon and Gresley locomotives that has since been quoted, I would like to add some corresponding figures for the Collin engines, based on my own observations. The following table gives details of some typical examples of high-power output, and, as in the case of the Gresley engines quoted in my letter in your issue of July 24th, allowance has been made for gradient when the observed particulars relate to uphill running.

Speed m.p.h.	D.H.P.	Proportion $\frac{\text{drawbar pull}}{\text{nominal T.E.}}$ per cent.
46	2000	44
58	2035	35·5
65	1905	29·7
77	1800	23·7

These results, taken from ordinary everyday running, are closely comparable with those of the Gresley "A4" streamlined "Pacifics," which appeared nearly five years after the Collin machines.

Events following the French military disaster of June, 1940, have no doubt tended to obliterate such individual characteristics of the former independent railway companies as had survived nationalisation; and for the present we have no detailed news as to how the surviving French locomotive stock is being used, rebuilt, or patched up. But when the time for reconstruction after the war does come, it seems fairly certain that the pre-Chapelon era will be little more than a memory. As it will inevitably be to Chapelon's work that French locomotive engineers will then turn in their enormous task, it is good to recall that, whatever may in the meantime happen to actual locomotives and railway equipment generally, the results of his epoch-making researches have been preserved for all time in his book "La Locomotive à Vapeur."

O. S. NOCK.

Chippenham, Wilts,
August 10th.

[This correspondence must now cease.—Ed. THE E.]

EDUCATION AND THE WAR EFFORT

SIR,—Your correspondent, Mr. Chorlton, might have made out his case for better mental training without the cheap jibe at the Army's present leaders, as being "the less intelligent boys of forty or fifty years ago." There is a hard saying of Marshal Foch: "La victoire va toujours à ceux qui la méritent par la plus grande force de volonté et d'intelligence." It will be noted that Foch puts "volonté" before "intelligence," and the full sense of that "volonté" cannot be given in one English word. Foch meant the same as Cromwell meant when he demanded "Valour, honour, and resolution" in the officer. It is only under the responsibility of command in war that these qualifications can be judged; so that selection on intelligence alone may lead to grievous misfits.

Mr. Chorlton is on sounder ground when he says that engineers should run engineering services; but the supreme control must remain with the statesman, who needs both "volonté" and "intelligence" in the highest degree, but would be no better for an "elementary knowledge" of the expert's job. The expert must be judged by his work, not corrected on details by the statesman. "A little knowledge" is proverbially dangerous. On the other hand, the Army would benefit by all its officers having engineering training.

Mr. Chorlton follows a prevailing fashion in attaching too much importance to school and college. Practical arts, such as those of the engineer, the sailor, and the soldier, can only be learnt by practice. The school and the college can develop character, teach first principles, and provide the scientific basis on which experience can build. The defect of the Civil Service system is that it makes "Treasury control" seem more important than getting on with the job; and this does not originate in school or college, but is imposed on the individual after entering the Service. This defect hampers the technical branches of the Service, which contains many first-class engineers. It needs correction from the top by a very strong Minister.

If the engineers had been more successful in keeping control of their own industry in peace, they might have been in a stronger position to pull their weight in war. May not this be partly due to a too-exclusive cult of technical knowledge, to the neglect of liberal education?

F. L. WATSON.

Leeds, 7, August 17th.

LATIN AND ENGINEERS

SIR,—I have noted last week's letter from "McAndrew," reporting an authority in education as saying, in effect, that a dead language was a better teaching subject for engineers than was the subject of engineering itself.

As long as engineers insist on devoting every hour of their time to studying this great and useful art, thereby altogether neglecting the social aspect, then such misleading statements will continue to emanate from those "in authority."

No wonder many a keen young engineer, these days, after half a lifetime of diligent effort, winds up subordinated to inexperienced and, naturally, unqualified, but seemingly influential, individuals.

We engineers are such individualists that our intentions preclude any thought of "unions"—thus is our problem more difficult.

August 11th. J. W. T.

Sixty Years Ago

ELECTRIC LOCOMOTIVES

IN our issue of August 25th, 1882, we discussed the possibilities of employing electricity as a motive power in transportation. Reviewing the history of the subject, we referred to experiments made in 1838 by Professor Jacobi at the expense of the Russian Government on the propulsion of a boat by electro-magnetism. The first attempt to propel a locomotive by electricity was attributed to Davidson, of Aberdeen, who in 1842 built and ran on the then newly opened Edinburgh and Glasgow Railway an electric locomotive which attained a speed of about 4 miles an hour. We stated that Davidson obtained his current from six batteries, each containing ten zinc plates, measuring 12in. by 15in., with iron plates between them. The current was taken to a crude form of motor, consisting of a wooden cylinder fixed to one of the axles and carrying bars of soft iron fitted into longitudinal grooves on its surface. The poles of horseshoe-shaped electro-magnets were disposed on opposite sides of the cylinder and a commutator was employed to render the magnets alternately active and inactive. With the development of the dynamo for electric lighting purposes, the subject attracted renewed attention. Credit for the first real practical application of electricity to the propulsion of trains was given to Siemens and Halske, of Berlin. A permanent electric railway on that firm's system was in operation at Berlin, and demonstrations had been given elsewhere, notably at the Crystal Palace, where the Bink's system, the same in principle as the Siemens, had been shown at work. The current generated by a fixed dynamo was led to one of the rails, and, after passing through the wheels to the motor—or being picked up by a brush—was returned by the other rail. Difficulties had been met in insulating the rails to the requisite degree, but hopes were entertained that new means of obtaining satisfactory insulation, devised by Professors Ayrton and Perry, would prove satisfactory under all weather conditions.

Sponge Iron

PLANS for an immediate study of the various methods of producing sponge iron and for the erection of pilot plants to guide future operations in this field have been launched by the United States Bureau of Mines. Funds totalling 600,000 dollars have been made available by Congress for the development of methods of utilising untouched iron ore deposits and to assist in alleviating a shortage of scrap iron now believed to be retarding steel-making.

Sponge iron—so-called because it is granular and porous—is the product of a process whereby metallic iron is obtained directly from iron ore without going through the liquid stage, such as that employed to produce pig iron in a blast-furnace. With natural gas or coal as the reducing agent, the oxygen is taken away from the ore at a temperature below the melting point of the iron or the iron oxide. The process is adaptable to smaller and therefore less expensive plants than the standard blast-furnace installation, and produces an iron which is low in carbon and therefore is comparable to scrap. A number of sponge iron reduction processes are known to be workable, but none of them has been applied commercially on a large scale to the United States iron ores because the standard reduction methods have produced a sufficient supply of iron in the past. As the war proceeds, the scrap shortage may become more acute, and sponge iron can take the place of scrap.

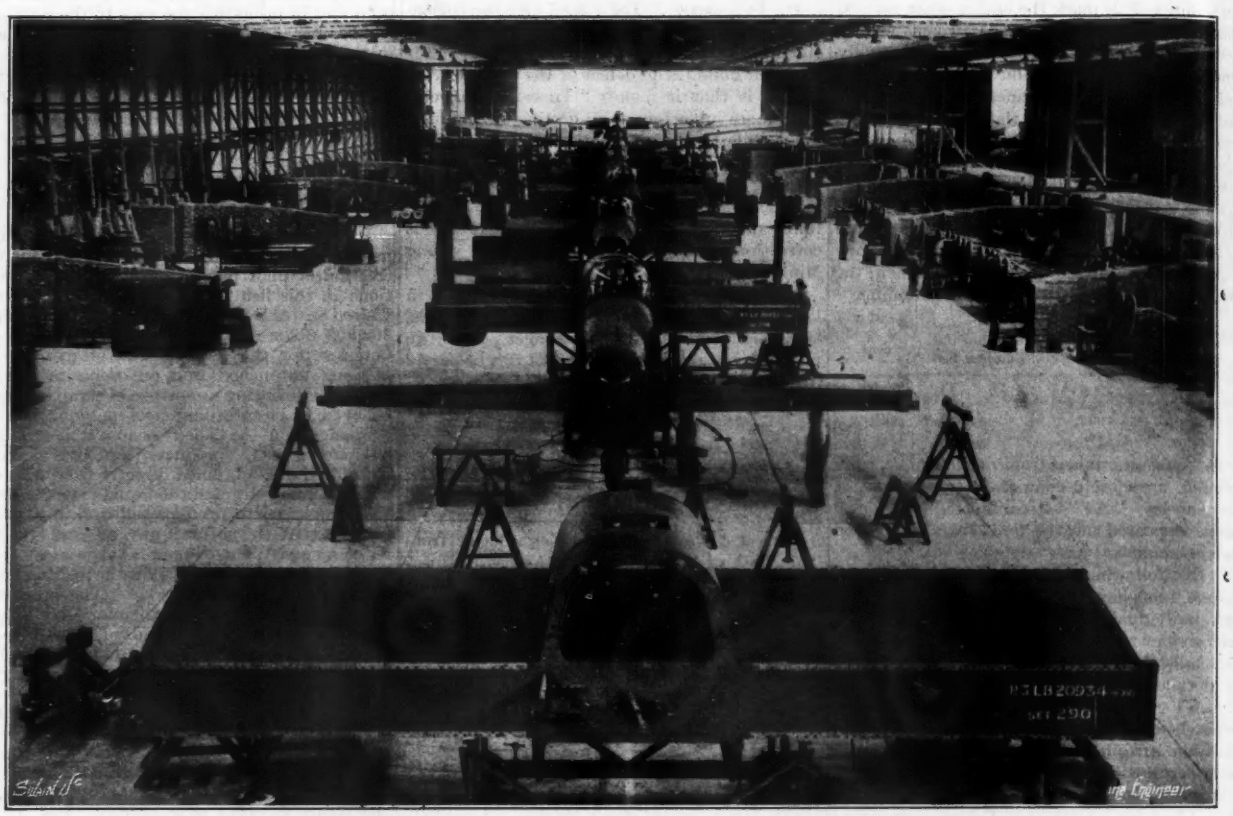
Past experiments of the Bureau of Mines and others have shown the feasibility of reducing iron ore directly with natural gas or coal, and it is with these two processes that the Bureau's initial work will be concerned. As long ago as 1927 the Bureau of Mines investigated the direct reduction of iron ores, and in 1936 it published a bulletin describing sponge iron experiments in California, with re-formed natural gas as the reducing agent. In this, the "gaseous reduction process," the carbon monoxide passing over hot ore reacts with the oxygen in the iron ore to form carbon dioxide and produces metallic iron. Coal of the non-coking type—and therefore less expensive—can also be used in another direct reduction process. The Bureau plans to make a survey of possible sites for two 30 to 50 tons a day pilot plants to test the various methods. The plants will probably be erected near large or unused iron ore deposits, depending upon a suitable supply of natural gas or coal.

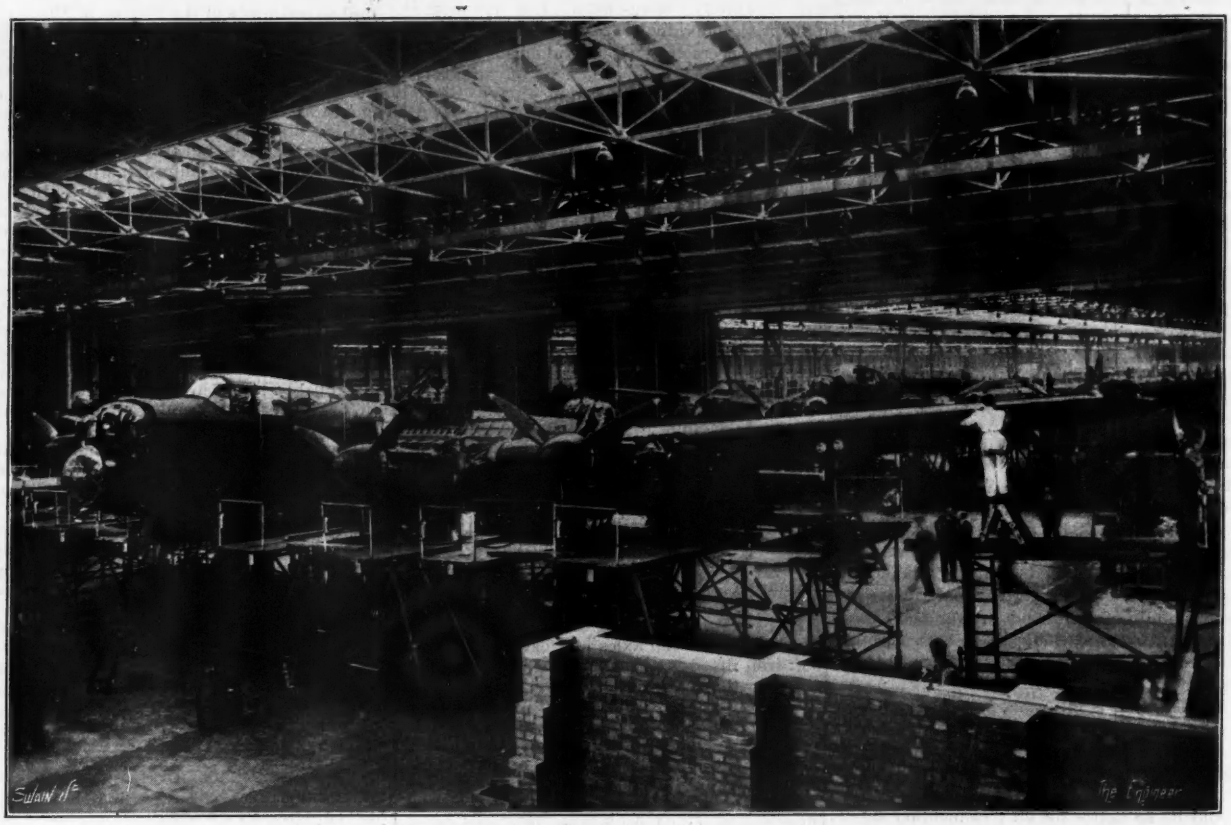
Because of its low carbon content, sponge iron is said to be an ideal substitute for scrap iron to mix with ordinary pig iron in manufacturing steel. Sponge iron plants can be built on a smaller scale than blast-furnaces, and small deposits of ore—too small to supply a modern blast-furnace—can be used to supply ore to a sponge iron plant. High-purity soft iron, containing only a small percentage of silica and free from carbon, is being demanded by electrical manufacturers, particularly for armatures. Iron produced by the gaseous reduction of high-purity iron oxide should provide this material.

END-ON LOADING.—The German transport authorities have recently introduced flat wagons for heavy loads, with end flaps for end-on loading, and raised supports movable lengthways and sideways. There are three types, all on bogies, with four or six wheels, to carry 46 or 80 metric tons.

ASSEMBLY OF AVRO "LANCASTER" HEAVY BOMBER

(For description see opposite page)





Beginning of Main Assembly Line

End of Main Assembly Line

The Avro "Lancaster" Heavy Bomber

No. II

(*Continued from page 130, August 14th*)

IN our last article we dealt with the general development of the "Lancaster" design, and described its arrangement and construction. We now pass to its production in one of the many factories devoted to its building, both in this country and in Canada.

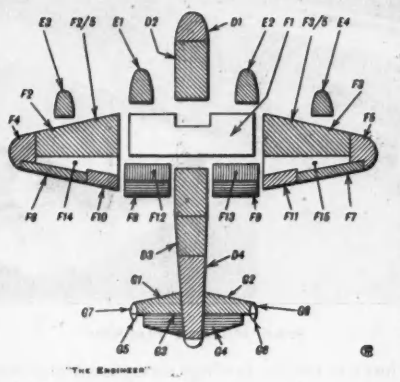
An interesting part of the organisation is the pre-planning department of the works, to which the drawings completed by the design department and drawing-office pass. It may be recorded that upwards of 50,000 separate parts go to make up the complete bomber, even if we exclude bolts and nuts, and count the engine units and gun turrets as single items. On these 50,000 parts, it is necessary to carry out something like half a million manufacturing operations. The pre-planning section of the works was called into being to study the planning and progress aspects of each manufacturing operation, and to produce a schedule of parts, giving not only details of each item and the equipment connected with it, but also recording the kind of jig required for the different machining operations and the materials, whether they be sheets, bars, rods, forgings, or castings. When completed, this schedule is available for each shop in the works and for such sub-contractors as may need it. In the matter of jig making, the closest touch is kept with the works, and before final decisions are come to the ideas of the planning department are checked with those of the works, on the type of jig for doing the work, and the best method of making a particular part. By means of the completed schedule of parts and their machining operations it becomes possible to determine the cost of each part and the number of man-hours needed to complete it, also the machine tools needed and the factory space called for. In time of war, labour conditions are exceptional, and it was with interest we learned that only about 10 per cent. of the employees engaged on the production of the bomber are skilled workers, while 50 per cent. of the remainder are women. The hours worked average sixty-one per week, and by care in planning it has been possible for A. V. Roe, Ltd., to arrange with the Ministry of Labour for labour supplies for a year ahead, thereby greatly simplifying the labour problems. The care which has been bestowed on the design of the "Lancaster" and its planned production has made it possible, we were informed, to cut down the number of man-hours needed for the construction of one aircraft to less than half the man-hours which some time ago were thought necessary for the building of a four-engined bomber.

SHOP METHODS AND SOME MACHINE TOOLS

In order to facilitate the work in the shops the work of construction is broken down to three main portions, illustrated herewith, the fuselage, the wings, and the tail. It may be noted from the diagram we produce that there are thirty-six assemblies covering the fuselage, wings, ailerons, flaps, trailing edges, and the tail.

In the actual manufacture considerable use is made of the drop hammer method of forming sheets with double curves. In this section of the works we noticed drop hammers by Brett's Patent Lifter Company, Ltd., and compressed air hammers by the Davy and United Engineering Company, Ltd. For the pressed sections produced from sheets a series of presses are used, and one particularly interesting machine in this section of the works is a 6600-ton hydraulic press, originally built by Henry Berry and Co., Ltd., for the paper industry, which has been modified by John Shaw (Salford) and Sons, Ltd., for aircraft production work. It works with a rubber platen and is served by two large table beds, the work being assembled on one while the other is below the press. Other presses in this section included machines by Taylor and Challen, Ltd.

The smaller parts made of sheet light alloy are produced, and complicated shapes, such



D 1.	Fuselage nose.
D 2.	Fuselage front section.
D 3.	Fuselage rear centre section.
D 4.	Fuselage rear section.
D 5.	Bomb doors.
D 6.	Bomb doors.
E 1.	Engine nacelle, port, inboard.
E 2.	Engine nacelle, starboard, inboard.
E 3.	Engine nacelle, port, outboard.
E 4.	Engine nacelle, starboard, outboard.
F 1.	Centre section of fuselage and wing.
F 2.	Wing, outer, port.
F 2/5.	Wing, outer detachable leading edge, port.
F 3.	Wing, outer, starboard.
F 3/5.	Wing, outer detachable leading edge, starboard.
F 4.	Wing tip, port.
F 5.	Wing tip, starboard.
F 6.	Aileron, port.
F 7.	Aileron, starboard.
F 8.	Centre section flap, inboard, port.
F 9.	Centre section flap, inboard, starboard.
F 10.	Wing, outer flap outboard, port.
F 11.	Wing, outer flap outboard, starboard.
F 12.	Centre section detachable trailing edge, port.
F 13.	Centre section detachable trailing edge, starboard.
F 14.	Wing, outer detachable trailing edge, port.
F 15.	Wing, outer detachable trailing edge, starboard
G 1.	Tail plane, port.
G 2.	Tail plane, starboard.
G 3.	Elevator, port.
G 4.	Elevator, starboard.
G 5.	Rudder, port.
G 6.	Rudder, starboard.
G 7.	Fin, port.
G 8.	Fin, starboard.
G.T.	Gun turret.

BREAKDOWN DIAGRAM.

as instrument panels, are cut out, in the routing department, which is equipped with machines by Wadkin, Ltd., similar to those we described and illustrated in our issue of May 15th last.

The strength sections of the "Lancaster's" wing structure take the form of long spars of dural metal, which are milled out from extruded bar of rectangular section. The bars are first split to make full use of the section and they are then milled out to channel form on Wadkin heavy spar milling machines. One of these L.Z. 2 milling machines, erected in the maker's works, is illustrated herewith. It has been specially built for the economic machining of long spars and has a fixed table, 36ft. long and 20in. wide, carried on a deep bed 42ft. long. This bed also forms the slide for the travelling cutter carriage on which the entire spindle housing and its feeding and transverse mechanism is housed. The spindle is directly driven by a variable-speed 25 B.H.P. Electric Construction Company motor, with a speed range from 1250 to 3000 r.p.m. The spindle has a nose of $5\frac{1}{16}$in. diameter, and is bored to British Standard taper. The outboard housing is of the triangular pattern and is arranged to swing 16in. cutters. The spindle carriage can be power traversed from left to right at feed speeds of 4in. to 36in. per minute, infinitely variable within this range. Pick-off gears give ranges of 1in. to 9in. and 2in. to 18in. feed speeds for skimming up jigs and other low-speed work. A quick reverse of 8ft. per minute is provided, and the headstock can be traversed by hand by means of a large hand wheel mounted on the spindle headstock. The longitudinal feed is operated by another variable-speed motor driving through pick-off gears and worm reduction gear to the rack and helical pinion. A dynamic brake for use with the trip dogs is provided. A rise and fall power traverse is also fitted to the spindle, giving a variable down feed of 1in. to 3in. per minute, and a quick approach and return of 9in. per minute. The push-button control to the feed motions is conveniently arranged near the operator on the spindle carriage. The machine is designed for A.C. supply, and the current is rectified in the control cubicle, which is built integrally with the machine on the cutter carriage. Altogether, ten push-button controls are provided. The cabling of the machine was designed and carried out by the makers, and a pay-out cable drum is fixed to the travelling cutter carriage, and so eliminates swinging cables. As will be seen from our engraving, a suds tank runs the full length of the machine, and a motor-driven suds pump unit on the carriage dips into the tank. A copying attachment is also provided.

On one of these spar milling machines A. V. Roe and Co. have fitted a hydraulic clamping attachment to the bed, which enables the spar to be clamped down in the short time of 7 min., compared with something like a time of $1\frac{1}{2}$ hours which would be required with two men setting the hand clamps. After the channelling operation is completed, the spars pass to a series of Wadkin drilling machines, after which they are ready for assembly.

Before leaving this section of the factory we may make brief reference to the large and well-equipped tool-room and jig section, which has a special temperature-controlled room with a series of Pratt and Whitney vertical and horizontal jig-boring machines.

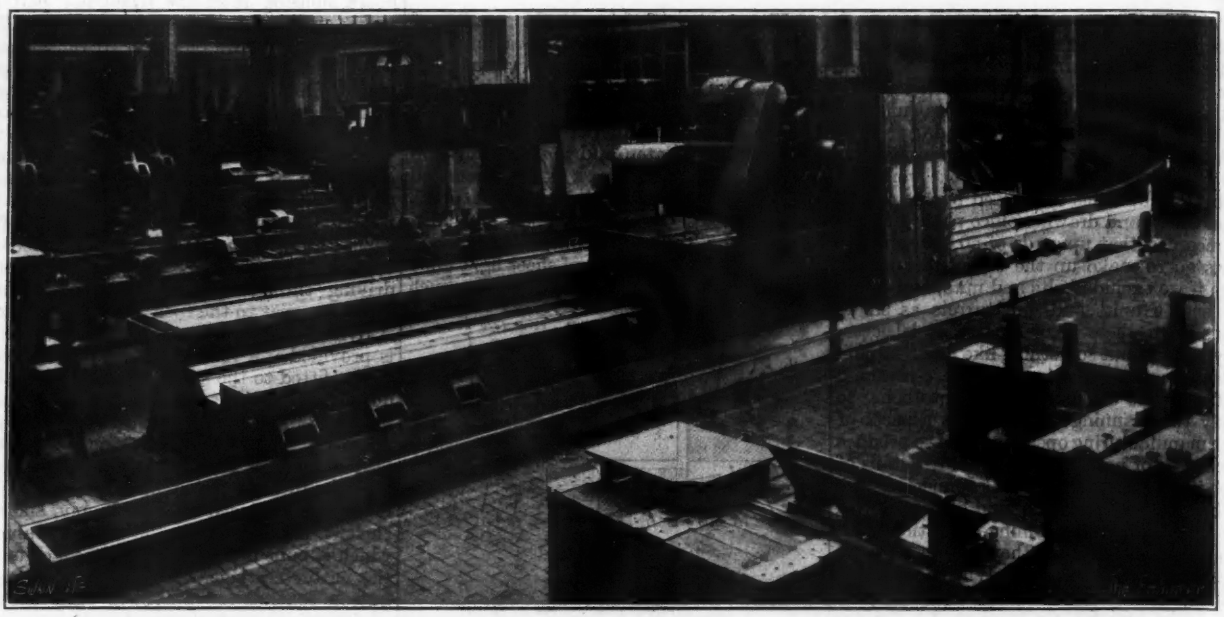
Before passing to the assembly sections all parts are heat treated and anodised.

The spars are assembled into the wing structures in large vertical jigs, and the same method is employed for the floors of the fuselage. One of our illustrations shows this operation, while another view illustrates the completion of a wing structure.

Before the wings are finally assembled the engine bearers are added to the front spar. These include two light alloy beams, the use of which has, we learned, eliminated some fifty parts, which were used on the prototype machine. This is one instance of the simplification of construction which has been adopted throughout. In this respect there is the closest co-operation between the jig department and the works in designing and trying out new types of jigs for the most efficient working.

In assembling the different sections of the machine all equipment is as far as possible added before final assembly takes place. An

interesting example of this practice is the fitting of the transparent cellulose acetate tank for the de-icing fluid for the air screw, which is placed behind each inner engine nacelle. The oil tank is also attached. The six fuel tanks are fitted to the wings; they are of spot-welded design, with the ends made petrol-tight by gas welding. Excluding the weight of the protecting covering and the fuel-jettisoning gear, the tank weight has been reduced by this method of manufacture to less than ½ lb. per gallon of fuel carried.

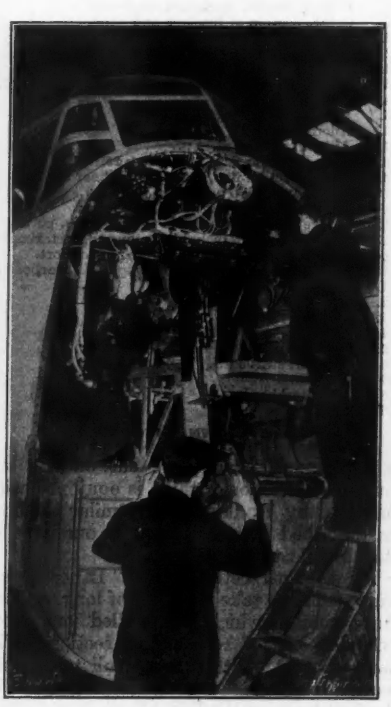


SPAR MILLING MACHINE

SECTION OF WING NEARING COMPLETION

FINAL ASSEMBLY

The two engravings we reproduce on an accompanying page show views of the beginning and end of the two main assembly lines. At the sides of the first view will be seen the parts ready for assembly. As will be seen in the foreground of the upper view, assembly starts with the centre section of the fuselage. The floor is the principal structural part, and is designed to take the full weight of the heaviest bombs carried. The formers for the fuselage structure are pressed and straightened, and are then attached to the floor sections, and the skin panels riveted on. Before the fuselage sections pass to the assembly lines, they are each completed as far as possible by adding all fittings. Thus the nose section has the front turret added and the controls for the rudder pedals, while the front section carries the transparent pilot's cockpit cover and the engine controls, and the rear section has the flare tubes and other internal fittings, such as the entrance door and the upper gun turret. The engines of the Rolls-Royce "Merlin XX" type, each having a designed output of 1250 H.P., come to the assembly lines as complete units, with their de Havilland Hydromatic three-bladed air-screws, engine cowlings and exhausts. These are coupled up with neat fairings for the engine nacelles. The Dowty under-carriage gears with Dunlop tyres and the rear landing wheel with Dowty shock-absorbing strut are built into their places. Our lower view on page 156 shows one of the bombers nearing completion, after which it will pass to the airfield for flight tests before handing over to the R.A.F.



FRONT SECTION OF FUSELAGE

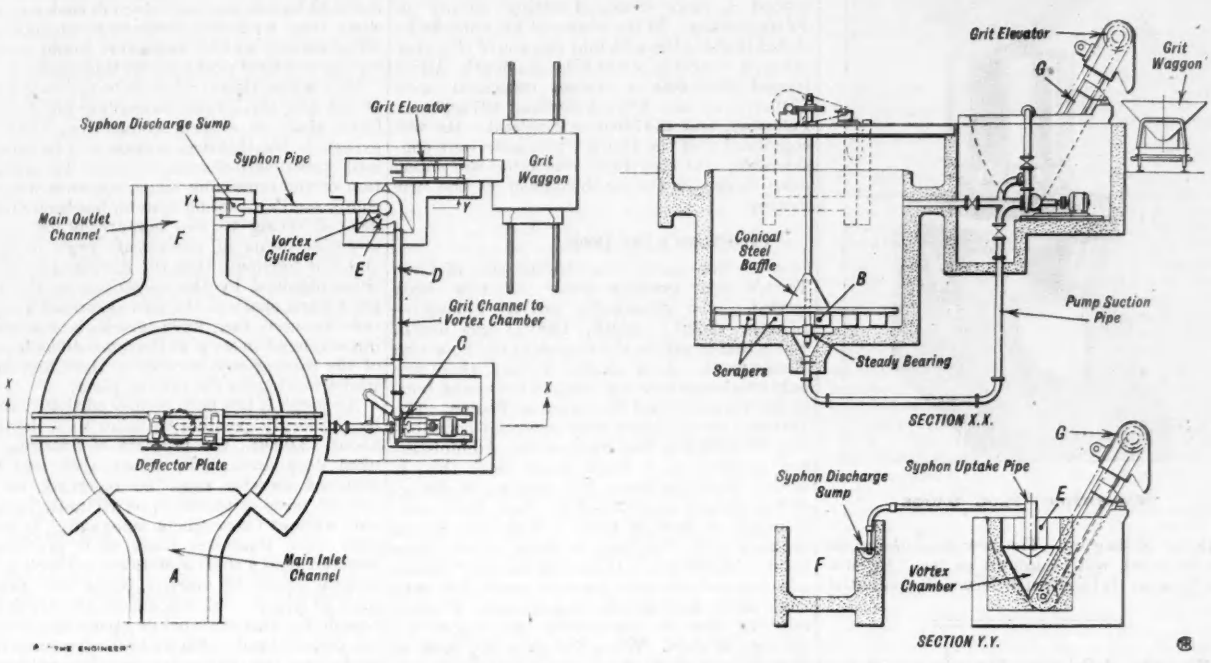
In conclusion, we may quote an extract from the Royal Air Force official test report, which Mr. Roy Chadwick, the designer of the "Lancaster," referred to after the luncheon which took place on the occasion of our recent visit to the works. It says: "The aircraft is eminently suited for operational duties. The performance and handling characteristics with full load surpass those of any other bomber. Even with two motors stopped on one side, the performance is exceptional. Baulked landings present no difficulties with 60,000 lb. loaded weight. Take-off and night landing are straightforward, and manœuvrability is good and

JIG FOR ERECTION OF FLOOR SECTIONS

evasive tactics easy." Such a report is itself a striking tribute to the firm of A. V. Roe and Co., Ltd., its designing and planning staff, and its many loyal employees.

Grit Separator

ALL who have had experience in the design or operation of sewage purification works are familiar with the difficulties encountered in separating grit in a clean state from organic solids. We have just received from Ames Crosta Mills and Co., Ltd., of Heywood, Lancashire, particulars of the Vortex grit separator. The drawing shows the arrangement of a typical plant making use of the device, and the makers point out that many alternative arrangements making use of the same device are possible. The main flow of sewage coming along the inlet channel A enters a circular tank of sufficient capacity to settle all grit at the maximum rate of flow. But at lower rates of flow organic solids will be settled in addition to the grit. In the bottom of the tank there is a mechanical scraper B. A motor-driven pump C draws off from the tank whenever the scraper is in operation. The flow from the pump, which contains all the settled solids is delivered to the Vortex separator E through the tangential feed channel D. Whirling conditions in the vortex chamber result in the separation of grit, which sinks through the water and of organic solids, which are withdrawn by a siphon pipe from the centre of the vortex and returned to the main sewage channel F. The separated grit is lifted by a bucket elevator G and deposited in trucks.

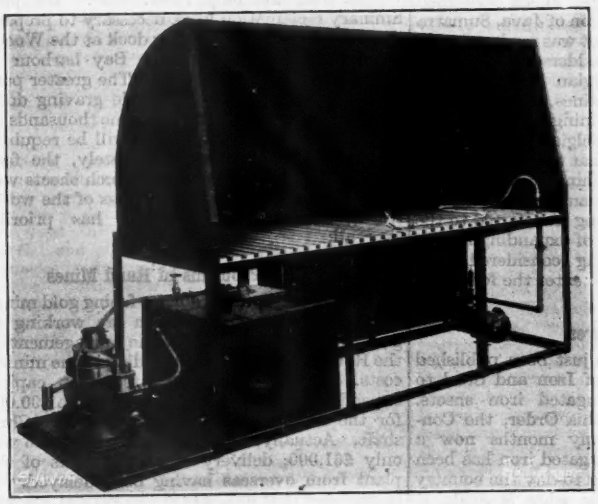


ARRANGEMENT OF GRIT SEPARATOR PLANT

Paraffin Wash Equipment

IN the various stages of producing machined components, designed to form part of power units, it is essential that these parts should be kept as clean as possible. This is true in the manufacture of motors, aero-engines, aircraft, ball bearings, &c. Several years before the war, Hopkinsons, Ltd., of Huddersfield, were approached by motor-car manufacturers with a view to developing a paraffin wash equipment for use in conjunction with their centrifugal separators, for the purpose of cleaning engine components coming off test. From experience gained with earlier installations, a highly developed range of paraffin wash booths is now available, of which the accompanying illustration shows, as an example, one of a batch recently supplied to a firm of aero-engine manufacturers. In addition to the booth, the plant includes a sump tank into which the oil and dirt from the washed parts fall. From this sump the oil overflows through a strainer into the dirty oil collecting tank fitted with a vertical centrifugal pump. That pump passes the oil to the Hopkinson separator in which all suspended dirt, small metal particles, water, &c., are continuously removed. A clean oil pump incorporated in the separator returns the purified oil to another tank from which a high-pressure centrifugal pump delivers the supply to the spray gun in the booth by way of special braided metal hose.

The booths are also made in rectangular forms, with operating platforms of either perforated steel or hardwood slats. For washing engine blocks and other heavy units brought to the booth on roller conveyors, the platform can also be formed of similar rollers, the work being passed into and away from the booth through sliding doors fitted at each end.



PARAFFIN WASH BOOTH

New Form of Plug Gauge

PLUG gauges for "go" and "not go" inspection are in use in many engineering works, but it is well known that this form of measurement has several shortcomings and is liable to error in operation. The principal disadvantages comprise :—(1) Loss of time caused by jamming, due to the insertion of the gauge at an angle. The operator gradually becomes skilled in gauge insertion, but, as the working day advances, fatigue tends to lessen the skill of the hands, and results in a loss of time in repeated efforts at correct insertion. (2) Misaligned approach causes excessive wear of the gauge and necessitates a more frequent checking of the gauge. In particular, jamming results in damage being caused by the severe and often drastic efforts of the operator to free the gauge and work. (3) If a piece is undersized, the operator will probably make several attempts to insert the gauge before finding out that the piece is actually a reject. Conversely, a correct piece may be rejected by reason of the operator persisting in a misaligned approach.

British Timken, Ltd., has developed a new form of plug gauge which, it claims, overcomes the usual difficulties, increases both the rate and accuracy of inspection, and permits working to closer tolerances. The gauge, as shown herewith, carries a ring of balls for guiding it into the hole. The balls are free to rotate in any direction and so effect immediate lining up of the gauge and work. A gauge can be held lightly and inserted easily in the work, even although the gauge diameter exactly equals that of the hole. Increased production, it is claimed, results from the simplicity and ease in operation of the gauge by unskilled labour, allowing more work to be gauged in a given time

with no risk of jamming, and consequent time loss, while there are fewer rejects. In addition, the new gauge has a longer life than the old type in general use. It does not jam, nor does it become ineffective through end wear, and the positive alignment avoids damage to the

"EMMERTON" PLUG GAUGE

work by picking up. The new plug gauge, we are informed, will be known as the "Emmerton" gauge. It has been provisionally patented.

South African Engineering Notes

(By our South African Correspondent)

CAPE TOWN, June 13th.

Congo to Treble its Tin Output

THE Belgian Congo hopes to treble its annual tin production by next year, and to increase its production of quinine and rubber to offset to some extent the losses sustained through the Japanese invasion of Java, Sumatra and Malaya. This statement was made recently by Mr. A. J. Moeller de Laddersous, Honorary Vice-Governor of the Belgian Congo, and a director of the Kilo Gold Mines, who is visiting South Africa to obtain mining equipment for the expansion of the Belgian Congo's tin industry. He also stated that the Congo's gold-mining industry was switching to the production of tin, and that as many gold miners as could be absorbed were being transferred to the tin mines. The possibility of expanding rubber production was also being considered, and natives were being asked to enter the forests to collect wild rubber.

Further Control Measures

Regulations have just been published by the Union Controller of Iron and Steel to control the sale of corrugated iron sheets. Explaining the need for this Order, the Controller states: "For many months now a negligible quantity of corrugated iron has been received from overseas, and to-day the country is practically dependent on what is made at the Iscor Steel Works (Pretoria). Fortunately the local output of corrugated iron has hitherto proved sufficient for urgent defence and essential Service needs, and there is from time to time a small balance available for the public. The object in introducing a permit system is to ensure that this balance will be used in the manner most beneficial to the whole country." He hoped that the permit system would prevent the misuse of corrugated iron on non-essential work. The Iscor Works, it may be mentioned, is preparing to manufacture as early as possible a sizable addition to the quantity now being produced. Unfortunately, the obtaining of necessary plant from overseas takes a very long time, under existing circumstances, so that no relief from this direction can be expected in the near future.

Gem diamonds is another direction in which control measures have now been extended, according to advice from London, which states that from June 1st licences will be required. However, in South Africa the diamond-cutting industry continues to go ahead, and on May 18th Colonel C. F. Stallard, Minister of Mines, opened a large diamond-cutting factory in Johannesburg. In the course of his remarks he stated that for the first four months of this year sales of cuttable diamonds in South Africa topped £650,000 in value, compared with £740,000 in the United States, £272,000 in Palestine, and £147,000 in England. He was convinced that the Union's prospects were considerable, and they fully warranted the enterprise shown in the establishment of the new factory.

Cape Town's Dry Dock

The question as to the size of Cape Town's new graving dock has now been settled. The dimensions are as follows:—Length, 1200ft.; width, 150ft.; and depth, 45ft.; and it will be the largest in the Southern Hemisphere. As a matter of fact, there are only two larger graving docks in the world, both in the French Naval Dockyard at Toulon. The British Government's very generous contribution of £750,000 has enabled the Administration to plan on a much larger scale than it would otherwise have felt justified in doing. It has always been urged by Cape Town that it would be best to build a dock that would accommodate the biggest ships afloat, even to the 85,000-ton "Queen Elizabeth," which war has proved may have to come this way while doing work of vital importance. There is rejoicing that the authorities have taken the far-sighted view. When the great dry dock at Durban was built, the mistake was made, not that the dock built there after the last war was not big enough—it is long enough to accommodate any ship afloat—but that it was not made wide enough to allow for future developments in ship design. Its width of 110ft. will not allow the biggest ships, either merchantmen or battleships, to go into it. One of the only two docks at Toulon that will be bigger than Cape Town's new one is also handicapped by being too narrow for its length, for it is 1318ft. long and only 118ft. wide. The preliminary reclamation work necessary to prepare the actual site of the graving dock at the Woodstock end of the new Table Bay harbour is now proceeding at full speed. The greater part of the dyke outlining the whole graving dock area is already above water. Some thousands of tons of corrugated iron sheets will be required for the cofferdam, but, fortunately, the fact that there is now control of all such sheets will make no difference to the progress of the work, as the Government demand has priority over all.

Ventilation Problems of Rand Mines

Ventilation problems facing gold mines on the Witwatersrand, which are working at great depths, now confront the management of the Robinson Deep and are adding to the mining costs. It had been estimated that capital expenditure for the past year would be £90,000 for the surface air-cooling plant at the Chris shaft. Actually, however, the expenditure was only £61,000, delivery of certain units of the plant from overseas having been delayed. It is expected that expenditure on capital account for the current year in respect of the air-cooling plant will be about £40,000.

The present extreme depth of the mine is at the face of 47 East 3 winze, 8600ft. below sea level, and the ventilation conditions on the mine continue to be the subject of intensive study, particularly with reference to circulating more cooled air through current workings at depth. The limitations of the existing shafts place a definite restriction on the improvements that can be achieved with air cooling and the possibilities of sinking a special shaft to a depth of 8000ft., to be used for ventilation purposes only, are being closely studied. This scheme would enable an additional volume of air to be delivered at depth, and is being considered as an alternative to underground refrigeration of present air quantities, which otherwise will eventually be required to supplement surface refrigeration at both the Turf and the Chris shafts. Designs of a shaft for ventilation purposes are being fully investigated from all points of view, but the provision of funds for the sinking of such a shaft presents an extremely difficult problem, although it is estimated that it would be less expensive to sink such a special shaft than to install large-scale underground refrigeration, which, moreover, would present serious practical problems on this mine.

Meanwhile, the erection of the first two stages of the new three-stage air-cooling plant at the Chris shaft is nearing completion, and it is expected that this first portion will be brought into operation in the near future. The installation of the remaining stage, together with the compressed air-cooling system, has been further delayed owing to the non-arrival of certain essential items of equipment from overseas, and it is fortunate that the increased air quantities obtained by the operations at the 46th level Chris shaft of the new downcast ventilation booster fan have given a reasonable improvement in some of the more difficult zones of the mining area served by the Chris shaft, whilst waiting for the cooling plant.

Although it has been estimated that it would be physically possible to mine to a depth of about 13,000ft., the problem of financing the ultra deep level shaft system that would be required therefor must be regarded, on the present basis of taxation, as virtually insuperable without Government assistance. It would take more than ten years after preliminary work on such a shaft system commenced before stoping could be started below the present limit of mining. This being so, the problem of completing this work before operations down to the present limit begin to decline becomes more acute, and the project becomes less practicable as each year goes by.

Bans and Restrictions

The number of commodities, of which the sale in the Union is either banned or restricted, is increasing almost daily. Among commodities banned are motor-cars and tyres, iron and steel products, india-rubber, wireless sets and motor oils, while the sales of maize, many foodstuffs, razor blades, cigarettes, soap, matches, crown corks, and much else are controlled, either as to quantity to be sold at one time or price, or both, and now a more sweeping measure appears likely to be taken. The need for some form of control on buying in the Union is being stressed, and it is being pointed out that replenishment difficulties and rising replacement costs of goods, as well as the growing public shopping demand and other competitive demands, have become accentuated in recent months. Higher prices may operate as a deterrent to Union competition for "unessential goods," but as the demand for a wide range of what are at present regarded as "necessities" will be only slightly affected, it is in regard to these basis purchases that the need for the control of competition by members of the public among themselves and in regard to the Government requirements, will become more pressing in the interests of national economy and of the national war effort.

REQUISITIONED ROAD VEHICLES.—From August 1st, 1942, responsibility for the acquisition of all used mechanically propelled road vehicles required by Government Departments has been centralised in the Ministry of War Transport. That Department has also assumed responsibility for the assessment, on behalf of Departments, of compensation payable under the Defence Acts in respect of such vehicles compulsorily acquired. A new branch of the Ministry, the Vehicle Acquisition and Compensation Branch, has been set up, and Mr. A. Warren Lambert, O.B.E., has been appointed Chief Assessor.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

General Notes

No decision has yet been made as to whether British iron and steel prices shall be raised. Meanwhile, higher ironstone miners' wages on the North-East Coast have had to be granted. The most important development recently in the British iron and steel trade position is the fact that the construction of numerous American aerodromes and other military establishments in this country is going to mean an intense call for all kinds of building material, including structural steel. As a matter of fact, heavy structural steel, which had been quiet for many months, has become an active market again. The tonnages needed for these new camps are certain to be large, and this new development may conceivably entail a certain strain on Britain's stocks of steel. Since these stocks were built up to a considerable extent as the result of previous American shipments to this country, it is only proper that they should now play their part in providing accommodation for American troops. Meanwhile, much interest has been aroused by the imminence of the arrival of an American Steel Mission in Great Britain to study British methods and requirements, to investigate means of increasing the quantity of steel available for the United Nations' war effort, and to ensure maximum efficiency in the allocation of America's contribution to the combined productive capacity of the two countries. British experience as regards the control of the iron and steel industry and distribution of supplies, British economies in saving special steels and methods of collecting scrap, will be the object of study, whilst shipping problems will also be investigated. When the American Mission has completed its work, a British Mission is likely to leave for the United States, possibly under the leadership of Sir Charles Wright, our Steel Controller.

The Pig Iron Market

With some consuming plants taking short holidays at the present time, there has been a slight relaxation in the demand for steel-making pig irons. This state of affairs will, of course, not last long and the output of the furnaces will be needed to the full in the coming months. Meanwhile, the call for foundry grades remains patchy. The light castings foundries continue to experience quiet conditions owing to the wartime depression in dwelling-house construction, whilst, in addition, the measures which are being taken to concentrate this industry make it cautious as regards placing new orders for material. However, the new big construction plans which are afoot in this country in connection with the establishment of numerous camps, aerodromes, and other military establishments for the American forces to be stationed in Britain may conceivably assist this branch of the industry, as it is already helping other sections. In addition, Government spokesmen recently threw out hints that Britain might embark on housing schemes even before the war ends; in such case the light castings works would immediately benefit. The heavy foundries meanwhile keep busy, since they are engaged on castings which are directly connected with the war effort, viz., heavy engineering and marine castings, &c. There seem to be adequate supplies of pig iron in the country, though consumers cannot always get the precise descriptions which they are accustomed to use in peacetime. Refined irons, as well as hematite, are now not too plentiful, but high-phosphoric irons are in many cases being used as substitutes. Basic pig iron supplies are fairly adequate, despite a good demand. Thanks to stocks of imported pig iron, English steel makers are able to maintain operations at a high rate. The Scottish pig iron industry remains very active and the pig iron supply position seems to have improved slightly.

The Midlands and South Wales

The Midland iron and steel works are resuming operations again after the recent holiday, which was welcome, as it gave managements a chance to overhaul machinery. The outlook for continued active employment in the area is favourable, in view of the heavy call for steel from the war factories. Particularly insistent is the demand for shipbuilding steel, but structural steel is also in active request with the main pressure still maintained for the lighter descriptions, although the mills rolling heavy structural steel seem to be better employed again after a lengthy lull. The Control is very strict as regards allocations. There is an enormous potential demand on non-essential account which cannot be satisfied under present conditions. The heavy foundries in the district have had a few days' holiday, but they are well booked on the manufacture of castings vitally needed by the munitions industry. Castings for tank production are needed in increasing quantities. The Control is closely supervising the pig iron situation and is only issuing hematite licences when alternatives cannot be used. Quiet conditions continue to rule in the light foundry trade. Alloy and special carbon steels are urgently called for as a result of the growing consumption in the war factories, and new plant is still being laid down. Special sheets and other specialities needed for the production of munitions are a busy section of the market. Black sheets are in better demand, but the production of galvanised sheets is now virtually at a standstill owing to the desirability of economising in the use of zinc. Good tonnages of colliery steel are being provided by the mills. The re-rollers are well booked, with a good demand for small angles and concrete bars. The finished iron industry seems to be slightly more active as regards the best grades of bar. Common bar mills remain fully booked and are not keen to accept much fresh business at the moment. Makers of crown bars and strip, however, are not over busy. In South Wales the steel works are under considerable buying pressure. The demand for plates is especially heavy, though structural material is a less busy department. The billet mills on the whole are well booked and the sheet and tinplate bar mills fairly active. The tinplate market is dull. Government orders for black and painted sheets are being placed in this area, but the production of galvanised sheets is down to a very low figure owing to the official restrictions on their use. The local demand for pig iron is excellent and the current production of Welsh basic and hematite pig iron is flowing into consumption without delay.

The North-East Coast and Yorkshire

The North-East Coast iron and steel works set a very good example to the rest of the country in forgoing their usual August holidays, though some of the consuming plants shut down for a few days. Delivery delays have lengthened, which demonstrates that the pressure on the plants has been expanding as a result of the rising tempo of the British war effort. The call for ship plates has been quieter owing to holidays at the shipyards, but this will only be a temporary phase and the mills can reckon on a sustained demand for their output as far as they can see ahead. Makers of heavy structural steel report an improved demand for their products, thanks to the "rush" construction of many new aerodromes and camps in this country. The same development has been responsible for an increase in the demand for black sheets, both plain and corrugated. The call for colliery steel has also expanded. Apart from ship plates, steel plates are urgently needed for the construction of tanks, wagons, and locomotives. The demand for special steel and alloy steel remains in excess of actual supply, and the demand for these materials will remain intense whilst the war lasts, since they are essential in the manufacture of key armaments. The re-rolling mills are active and adequate supplies of their raw materials are still obtainable, though it is believed that stocks of these may eventually tend to fall owing to intensified war demands and the limitation of imports which has occurred in recent months. Finished steel generally is going into consumption quickly. In Yorkshire many works have had two weeks' holiday, but production at the steel works is being resumed and an increased output is expected. The demand for special and alloy steels remains intense and the furnaces producing these steels can look forward to active conditions for a long time to come. Owing to the holidays, there has been an opportunity to effect urgent renewals at the plants, including steel furnaces. Makers of structural steel and plates are well booked. In some works the provision of adequate supplies of labour presents a problem, but the increased use of women is helping works' managements to a considerable degree; in fact, the proportion of female workers employed at some works is astonishing and quite heavy and skilled work is undertaken by many of them.

Scotland and the North

During the recent steel works holiday the blast-furnaces accumulated a certain reserve stock of pig iron, and this is helping the supply situation to some degree, although consumers would be happier if the Control were able to release larger supplies of hematite for them. Now that the holidays are out of the way the steel industry has resumed operations at a high rate, and in view of the war situation works are likely to remain very busy as far as can be seen ahead. The industry is not worried about raw materials, since alternative sources of iron ore supply (including increased domestic output) have been opened up since normal supplying areas were closed to us; whilst the scrap collection drive is resulting in embarrassingly good results. Some of the scrap coming forward is by no means of the quality which works would choose in peacetime, but this is a minor matter. Demand presses particularly heavily on ship plates, shipbuilding material generally, and plates for boilers and tanks. Tube makers are fairly busy, but the sheet mills, despite an improvement in demand, seem to have spare capacity in many cases. There is a lively demand for special steels and armour plate. Good employment conditions are recorded in the rivet, nut, and bolt trade. The local light castings foundries (which are mainly dependent on English pig iron) remain quiet, but the heavy foundries find it difficult to satisfy the spate of orders. In Lancashire foundry grades of pig iron are in poor request, although there is a good inquiry for special grades. The foundries are cautious as regards new buying commitments in any case, as they are not sure what will be the final outcome of the concentration proposals. Obviously, works which may have to close down or reduce operations would be unwise to order more iron than they need to carry on operations for the time being. Meanwhile, many of the heavy foundries are fully employed. Forge pig iron is quiet, but steady. The finished iron market has been dull, though a certain amount of business has been done in best Yorkshire bars and Crown quality bars. Steel plates are being disposed of steadily to boilermakers, tank makers, locomotive works, and heavy electrical engineering plants. There is a widespread demand for steel bars. Semi-finished steel is in good request, and the same remarks apply to sheets and colliery steel. On the North-West Coast producers of hematite pig iron seem to be able to satisfy local demands, but they cannot spare much iron for users in the Midlands and Scotland.

Copper, Tin, Lead, and Spelter

The tendency is still for the demand for copper to increase to keep pace with the appetite of the war programme, but as a Government spokesman recently pointed out, the labour situation is such that further increases in production may be of a limited character. Works producing semi-finished materials have some reserve capacity, but they are unable to use it until or unless additional labour is forthcoming, the prospects of which at the moment are not particularly good. The supply of raw copper has been very well maintained, manufacturers everywhere reporting no difficulty on this score. Nevertheless, the use of virgin metal is being kept as low as possible by the utilisation of scrap and secondary material. There are no signs as yet of this country forsaking brass shell cases for steel—as is gradually being done in the United States—although no doubt the situation is being closely watched and arranged in accordance with the relative supply positions here of copper and steel. In America, despite record supplies, the war production chiefs are having to exercise careful supervision over the allocation of material, as potential demands are in excess of current production and imports. . . . The tin position shows no alteration compared with recent weeks. Supplies in this country, for the uses for which tin is still allowed, are fully adequate, but taking the position of the United Nations as a whole, the call is for larger production, and efforts are being made to recruit large numbers of additional labourers in Nigeria. Bolivia, although now benefiting from a substantially higher price, is finding expansion in output difficult, owing to labour shortage. The programme for the conservation of tin is gaining efficiency, as revised specifications for bronzes, bearing metals, solders, &c., become more widely adopted. . . . The demand for lead from cable and battery makers is maintained at a high level in connection with Government work, and supplies for such purposes are fully adequate. Solder is using rather more lead in order to save tin, and the same is true of bearing metals for non-essential consumption. Very little metal is now being released, but Government building plans for housing American troops may result in more lead products being required. . . . Demand for spelter is on a very large scale, primarily from the brass industry, which is working at a very high rate of munitions production, but also to a considerable extent for zinc alloy die castings, the consumption of which has risen very markedly since the war began. Other uses, such as galvanising, have been heavily cut in order to make the available supplies meet the vital needs. America is experiencing some tightness in supplies of high-grade metal, but, generally speaking, is in a reasonably satisfactory position.

Notes and Memoranda

Rail and Road

Manchester Buses on Loan.—Despite its own war demands, the Manchester Corporation transport department has lent some of its buses to other operators at various times, including Coventry Corporation Transport, Crosville Motor Services, Ltd., the Lancashire United Transport and Power Company, Ltd., the Liverpool Corporation Passenger Transport, and the London Passenger Transport Board.

Another Shortage of Fuel.—The Argentina Railways are among the latest victims of fuel shortage, and have appealed to the Government Railway Board. They suggest that the fuel shortage should be remedied by reducing the number of trains and their speed, increasing the number of cars for each train, and exempting the companies of all responsibility when goods are not delivered to time.

A Solution of a Gauge Problem.—Swiss railway engineers have designed and made transporter wagons by means of which the standard-gauge Berne-Lœtschberg-Simplon line between Zweisimmen, Spiez, and Interlaken (Ost) can be linked directly with the metre-gauge Brünig section of the Swiss Federal Railways and elsewhere. Each transporter vehicle is built to accommodate two four-wheel narrow-gauge wagons, and special loading docks at Zweisimmen and Interlaken allow the narrow-gauge wagons to be run directly on to and off the transporters.

Collapse of a Stone Arch Bridge.—One of the oldest stone arch bridges in the United States—built in 1809, near Frederick, Md.—has collapsed under continually increasing motor traffic. The structure consisted of four arch spans with 70ft. clear openings. In February of this year the load limit of the bridge was reduced. The final failure occurred a few weeks ago after several days of heavy rain. A new bridge, a short way downstream, and a relocation of the highway which leads to the old structure are already planned, and will be started during the present year.

Road and Rail Services in the U.S.A.—The United States Office of Defence Transportation has authorised the Northern Pacific Railroad to substitute road motor and lorry service for its passenger express and mail service over the 71-mile line between Logan, Montana, and Butte. The authorisation, which is the first of its kind, has been granted on the grounds that the railway company already owns the necessary buses and lorries, and that by the substitution two "Pacific" locomotives and a number of passenger coaches will be released to meet urgent needs elsewhere.

New Motor-cars.—A parliamentary reply by the Joint Secretary to the Ministry of War Transport states that, during the six months ended June 30th last, 1292 licences were issued to persons or firms engaged in work of national importance to acquire 1620 unregistered motor-cars. Included in these numbers are those sanctioned for use by the Police and Government Departments. During the same period 543 applications were refused. Arrangements have been made to terminate the manufacture of motor-cars in the near future, but so long as they are available they will be accorded to those who can show that they have the greatest need for a new car.

Air and Water

Parsons Memorial Lecture.—The Institute of Marine Engineers has made arrangements for the Parsons Memorial Lecture, 1942, to be delivered by Dr. S. F. Dorey on September 16th at the Institution of Mechanical Engineers, Storey's Gate, S.W.1. The title of the lecture will be "Reduction Gearing for Marine Steam Turbines."

South American Airways.—Pan American Airways, Inc., has inaugurated an air line across South America from Rio de Janeiro to Lima, Peru, on the Pacific coast. The new passenger service connects the Brazilian capital with San Paulo and Corumba in Brazil with Puerto Suarez, Santa Cruz, Cocabamba, and Oruro in Bolivia, and Arequipa and Lima in Peru.

Shipbuilding in India.—The shipbuilding yards in India are working to full capacity on the construction of naval vessels of various types. More than 300 are under construction, including trawlers, corvettes, steam and motor launches, motor minesweepers, mine-sweeping tugs, lifeboats, skids which are towed behind vessels and explode mines, motor cutters, and other sea-going and coastal craft. Besides these, several large mercantile vessels and floating docks are in hand. It is reported that over 30,000 men are engaged in the various shipbuilding and repairing yards in the country. In addition, shipbuilders are employed on extensive repairs to merchant ships. Approximately 4000 sea-going ships have been repaired at the Indian yards since the outbreak of war.

U.S.A. Bridge Award.—We have already mentioned that the award made by the American Institute of Steel Construction for the most beautiful bridge opened in 1941 went to the Rainbow bridge over the Niagara River. The complete list has since been published and announces that the Passaic River bridge on the Lincoln Highway between Newark and Kearny, New Jersey, has been selected as the most beautiful movable bridge erected during 1941. Costing over 2,000,000 dollars, the bridge was opened to traffic on January 26th, 1941, and is owned by the State Highway Department of New Jersey.

Miscellanea

Another Source of Chrome Ore.—It is reported that a good seam of chrome ore has been discovered near Lalapanzi, Southern Rhodesia.

Export Prices of Machine Tools.—Export prices for new machine tools produced in the United Kingdom are now controlled by an Order issued by the Minister of Supply. The Order, the Control of Machine Tools (No. 12) Order, 1942, which came into operation on August 15th, is obtainable from H.M. Stationery Office, Kingsway, W.C.2, price 1d., or through any bookseller.

Tin Can Scrap.—The U.S.A. War Department has decided that tin can scrap throughout the country will have to be accumulated to await large-scale detinning operations after Government plans are completed. There seems to be little chance that tin can scrap will be utilised in the open-hearth furnaces, owing to the bad effects of tin in heats of steel where such scrap is used. Open-hearth operators are more determined than ever to keep tin can scrap out of their furnaces.

Plywood in Industry.—In common with other wood-producing countries, India is intensively studying the possibilities of plywood, and the Forest Research Institute, Dehra Dun, has recently published its third Forest Record, dealing with the testing of Indian timbers for veneers and plywood. There are now nine plywood factories in India; one in the Punjab, one in the United Provinces, one in Travancore, two in Madras, two in Bengal, and two in Assam, and Bombay is likely to start factories in the near future. The report describes the work done on thirty-four species of Indian timbers.

The Late Mr. James Anderson.—It is with regret that we have to record the death, on August 14th, of Mr. James Anderson, M.I.E.E., who had been chief engineer of George Ellison, Ltd., Birmingham, for the past twenty-eight years. The early years of Mr. Anderson's professional life was spent in South America, and at the age of twenty-seven he was appointed chief engineer at the Rasario power station. Later he joined the staff of Ferranti, Ltd., and as outside superintendent was responsible for the erection of their equipment in this country and in the South African goldfields. He joined the staff of George Ellison, Ltd., in 1914. During his association with that firm his activities were mainly directed to research. He wrote numerous papers and articles, and was the author of "A Study by Means of Photography of the Interruption of Medium Power Electrical Circuits." Mr. Anderson was sixty-nine years of age.

Duplication of Advice on Lighting.—The large amount of industrial re-lighting made necessary by war conditions has imposed a severe strain on the resources of illuminating engineering firms, whose technical specialists are called upon to plan lighting schemes. There is a serious shortage of experts in this field of engineering, and even were it possible to obtain more staff for this purpose their training would take many months. The National Industrial Electric Lighting Service, 2, Savoy Hill, London, W.C.2, states that it would be of the greatest possible assistance to the lighting industry and assist the national effort if factory executives would forgo their established practice of obtaining numbers of alternative plans for any amendment needed in their lighting installation. It is often found that specifications are being sought from several lighting firms for quite small jobs, and in this way the unsuccessful firms waste many technical man-hours in preparing their alternative schemes, which, in straightforward jobs, are likely to be very similar, varying only in detail. While there are many cases where it is entirely justifiable and desirable to obtain an alternative specification for an important job, factory executives are asked to exercise discretion in this matter. There is no desire to hinder them in obtaining a reasonable number of estimates based on the same specification, as the routine office work entailed can be done by less highly trained staff; but by easing the load on the technical specialists, executives will contribute materially towards the provision, in other factories, of proper lighting for war production.

Are Limits Too Fine?—Sir Alfred Herbert, in a recent issue of *The Machinist*, answered this question in the affirmative, at least in certain circumstances. With some work, he wrote, extreme accuracy was a virtue, and on such work fine limits must be specified and maintained, but there were plenty of jobs when insistence on extremely fine limits was a vice, for it involved (1) reduction in output, (2) waste of time, labour and material through excessive rejections, (3) unnecessary stoppage of machines for regrinding and resetting tools. It was the last split-thousandth that cost the money.

Resistance Welding Machines.—In order to ensure a balanced supply of resistance welding machines, no order received on or after July 27th may be accepted by a manufacturer or an agent for a new resistance welding machine unless authority from the Machine Tool Control has first been received. All Government Departments are being advised that if they require resistance welding machines, they must first submit the particulars of their requirements to the Machine Tool Control. The Machine Tool Control will advise the Department of the name of the supplier whom the Control is authorising to execute the order. The suppliers in turn will be advised of the authorisation.

Personal and Business

Mr. E. M. Fraser has been appointed Director-General of Equipment Production, Ministry of Aircraft Production.

J. Samuel White and Co., Ltd., inform us that their London address is now Whitehall House, 41, Whitehall, S.W.1.

Mr. William Muckle has been appointed Lecturer in Naval Architecture at King's College, Newcastle-upon-Tyne.

Commander Stephen King-Hall, R.N., Retd., has been appointed Chairman of the Fuel Economy Publicity Committee by the Minister of Fuel and Power.

Mr. W. H. Heaton has retired after thirty years' service as works manager at the Witton works of the General Electric Company, Ltd. He will continue to serve the company in an advisory capacity.

Mr. J. M. Watson has been appointed managing director of Ailsa Craig, Ltd., Strand-on-the-Green, Chiswick, London, W.4. Mr. Watson served his apprenticeship with Ailsa Craig thirty-four years ago, and returns to the firm after having held executive positions with Gardners, Ruston-Lister, Davey-Paxman, and Petters.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institution of Automobile Engineers

Tuesday, Sept. 1st.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "Supercharging the Compression Ignition Engine," Mr. C. B. Dicksee. 6 p.m.

Institution of Civil Engineers

Tuesday, Aug. 25th.—Great George Street, S.W.1. Conference, "Civil Engineers and the Building Industry," opened by Professor C. E. Inglis. 2.30 p.m.

Institution of Electrical Engineers

Saturday, Sept. 5th.—London Students: Visit to works of the Fuller Electrical and Manufacturing Company, Ltd. 1.30 p.m.

Institution of Production Engineers

Sunday, Sept. 6th.—Luton Section: George Hotel, Luton. "Tungsten Carbide Cutting Tools," Mr. F. H. Bates. 10 a.m.

Men of Maudslays

Friday, Aug. 21st.—Visit to the works of Mr. E. G. Izod. Full particulars will be notified to members.

North of England Institute of Mining and Mechanical Engineers

Saturday, Aug. 22nd.—Neville Hall, Newcastle-upon-Tyne. Annual general meeting. 2 p.m.